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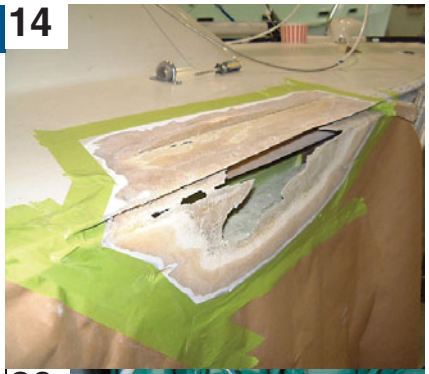

CURRENTS

EDITED BY JAN MUNDY

A Half Cell of Table Salt?

"Corrosion Control," written by Susan Canfield in DIY 2003-#2 issue was certainly a winner as we heard from numerous readers about a blatant and reoccurring error.

The article mentions the use of a silver/silver chloride half-cell, and then gives the chemical symbol as Na/NaCl, which is the symbol for sodium/sodium chloride, more commonly known as table salt, which certainly would yield different results. The chemical symbol for silver/silver chloride should read Ag/AgCl. Thanks for the heads-up from all readers who contacted us.

Styling Trends for 2004

According to David McCracken, styling manager of Omnova Solutions (web: www.omnova.com), conservative colors blended with textured fabrics and graphics will ride

the wave on next year's models.

Marine color trends closely follow those seen in the automotive and home markets, which for next year are somewhat conservative. The traditional red, black and blue colors return for another year with more vibrant color limited to accent colors of purple, teal and pastels. Classic colors remain the norm for boat interiors. An important addition is textures. Expect to see metallic, soft metal flake, diamond check patterns, gator skin, geometrics, verticals, wovens and animal skins for the more adventuresome.

Yes, Do Carry Expired Flares

In DIY 2003-#2 issue there is a discussion on expired flares (see "When Smoke Signals, Rockets and Meteor Flares Expire). I have been told that the Coast Guard bestows fines having outdated flares onboard, regardless if there are the correct number and type of in-date flares. I always kept the old ones to use first in an emergency but hesitate to do so now.
Ion Barnes via email

Not true. The following is from the Coast Guard website (www.uscgboating.org/safety/fed_reqs/equ_vds.htm).

"Pyrotechnic visual distress signals must be Coast Guard approved, in serviceable condition, and readily accessible. They are marked with an expiration date. Expired signals may be carried as extra equipment, but can not be counted toward meeting the visual distress signal requirement, since they may be unreliable. A watertight container, painted red or orange and prominently marked Distress Signals or Flares, is recommended." To eliminate any confusion, it's a good idea to segregate expired and unexpired signals in separate, clearly labeled containers.
— Sue Canfield

When is a Captain not a Captain?

Anyone can be a captain of a recreational boat, small or large. You can call yourself "captain" or the "skipper" with full confidence that the term applies whether you are rowing a skiff, steering a sloop or at the helm of a powerful motorboat. You can also be the captain of a passenger-carrying vessel and, if you are a civilian, that will earn you the title of "licensed operator." So, what's a "captain's license?"

This is a label that has been inaccurately applied to the status held in the United States when a civilian successfully completes the requirements to earn a license to operate passenger-carrying vessels. There are many classes of these licenses that define the boundaries of the holder's legal limits of operation, such as size of vessel, waters in which the holder can legally operate a passenger vessel and the number of persons onboard that vessel. To

WHY USE MARINE PAINTS?

Ever wondered why we don't recommend using automotive or house paints in lieu of marine paints? Or why marine paints are so much more expensive than other coatings? We questioned this as well and asked Interlux for clarification, receiving a response from Jim Seidel.

"Resins used for house paints are generally darker, which can effect the final color of the paint. Bright colors, especially whites, are necessary for marine paints so resins, such as Soya or safflower, are used to help achieve brighter colors. Less-expensive linseed oil resins are used in household products and while you can get a good white, it doesn't have the same clarity (distinction of image) or gloss. Automotive finishes are formulated for application techniques generally used in that industry for production and refinishing and have greatly different properties. In reality, marine finishes are much better than automotive finishes. Just look at the finish of a late model car, even an expensive one, and you'll notice a lot of orange peel in the finish. This is built into the paint to help disguise small defects in the metal. I doubt a boat owner would accept the same level of peel in the finish of his or her boat."

Diesel Engine Poll Results

What brand of diesel engine powers your boat?

We thought we had the bulk of the most popular diesel engine brands listed in the survey posted on DIY ONLINE. But obviously not, as more than 14% selected "Other" as their brand. Complete results in alphabetical order were: Caterpillar, 3%; Cummins, 5%; Detroit Diesel, 5%; John Deere, 2%; Kubota, 4%; Perkins, 11%; Vetus, 2%, Volvo, 19%; Westerbeke, 8%; Yanmar, 27%. In the "Other" category would be Lister, Mann, Pathfinder, Nannidiesel, Farymann and others we neglected to list.

COMPASS SWINGS

Compasses were invented 4,000 years ago and until now, no manufacturer has been able to solve the problem of global balancing. The earth's magnetic fields cause compass cards to dip when traveling from Northern to Southern latitudes. Manufacturers manually balance the cards for the different locales. A compass, for example, that is balanced for New York may dip by the time the boat arrives in Australia. Danforth Compass has eliminated all card balancing with the development of the new patent-pending GlobalBalance Card System. By decoupling the magnet and completely surrounding the card by dampening fluid within a float chamber, the card is free to pivot north and south with the change in the magnetic field. Effectively, the floatation chamber makes it neutrally bouyant so the compass card remains perfectly level anywhere in the world. An added benefit of the floatation system is enhanced stability, particularly with smaller compasses that tend to rotate or spin in rough seas.

GlobalBalance Card System is available in a range of sizes from the 6.6cm (2-5/8") Skipper model up to the 11.4cm (4-1/2") Constellation in all card styles: flat, front reading and dual reading. Danforth can retrofit other existing compasses. For the Corsair and Saturn modular compasses, you can purchase a replacement capsule.

The practical benefit of this innovation is that Danforth no longer needs to balance cards in-house. The net savings to consumers, besides balancing and vibration-free operation, is no price increase. As with any compass, you still need to boat compensate the compass to allow for onboard deviation.

the surprise of most boaters and to the consternation of many holders of these licenses, nowhere on the certificate does the word "captain" appear. The license does not award or impose a rank of any kind. You are addressed as "Captain" if you hold rank in the military, Coast Guard, fire and police departments.

In the case of the licensed operator, the use of the common vernacular "captain" is fine to designate who is in charge. The captain is just that, the captain of the vessel but he or she is not a "licensed captain." Holding an operator's license does not necessary mean that one is a "captain."

PAT KEARNS

"I was just following the Handicapped Parking sign."

This may sound a bit like hair-splitting but being accurate about the nomenclature of the entitlement is part of the responsibility. If you are seeking expert knowledge in matters marine, make sure that you are not mislead by the business card that prefixes the card owner's name with Captain. That doesn't happen until that operator takes command of a vessel. Neither does this guarantee that they are expert in all things marine. Make sure the title suits the status. That's where the real professionalism lives.

— Pat Kearns

Moisture Barrier for Bunks

Condensation is the bane that creates moldy cushions or mattresses. Our boat was no exception. Installation of a few solar vents certainly helped but the problem remained. While attending a boat show in Florida, where combating dampness is certainly more of a problem than in Northern States, we discovered HyperVent.

Unquestionably, this is the most practical solution for the prevention of condensation forming beneath berths and seats. HyperVent consists of a rigid, 19mm- (3/4"-) thick, coarsely spun polymer that's heat-fused to a breathable fabric. Since this wire-like mesh doesn't compress, it creates an airspace that allows moisture to escape, eliminating any chance of mildew build up.

Available in 99cm (39") and lengths up to 30.4m (100'), it sells for US$7.25 per linear 30.4cm (foot). Panels are easily cut with scissors and sections are glued together to form the desired shape. Lightweight, it weighs just 3.6 grams per square meter (4.3 oz per square yard). One note of caution: cut the HyperVent at least 25cm (1") undersized to keep the material from peeking out from beneath cushions. The coarse wire-like mesh can easily scrape legs and hands.

For the name of your nearest distributor, contact Hypervent Marine, Tel: 619/224-5626, Web: www.hyperventmarine.com.

— Jan Mundy

Recall from Blue Sea

Blue Sea Systems has issued a voluntary recall of its T-1 Circuit Breaker, citing a potential safety problem. There is a possible fire risk if the operator holds the circuit breaker handle in the "On" position after the unit has tripped, causing the contacts to weld together.

The company says that boaters who own any of the surface mount or panel mount versions of this product (surface mount Part No. 7120-7133; panel mount Part No. 7020-7033) can arrange for a free replacement by visiting the Blue Sea Systems Web site, www.bluesea.com, or call the company at 800/222-7617. You'll be required to provide the part number and serial number.

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ARE MARELON AND BRONZE COMPATIBLE?

The article titled, "Water-Tight Fittings," in DIY 2003-#1 issue, stated not to mix metal and plastic fittings: "An example of this is coupling a bronze thru-hull with a Marelon valve."

According to Bill Mosher of Forespar, this is not the case. Bill explains: "This is a myth that continues to appear in technical articles and we get frustrated when reading this information. Many builders have used this combination successfully for years."

Before putting ink to paper, DIY wanted to verify the correct procedures so we arranged for a demonstration with Art Bandy, Forespar's technical guru. If you plan to connect Marelon and bronze, carefully follow the guidelines below.

Before putting any synthetic valve onto bronze, the thread match is very important. Bronze easily cross-threads into plastic. Bronze marine valves have a parallel thread (as shown in photo). Valves sold for home and commercial use have a tapered thread. Coupling a tapered to a parallel thread delivers limited engagement and a weak seal. Moreover, many thru-hull-valve-hose barb installations don't pass ABYC's 226.8kg (500lb) load test. [For a complete description, refer to "Water-Tight Fittings" in DIY 2003-#1 issue.) Art suggests that smaller diameter assemblies, 12mm (1/2") and 19mm (3/4"), don't pass this test. Because of this, Art recommends connecting only the larger diameter thru-hulls and valves. Use Teflon tape, polyurethane sealant or pipe dope provided it's compatible with nylon. Read the label carefully. There are some dopes with strong acid base that will attack nylon. The best installation and one that usually passes the load test and is fully compliant with ABYC and ISO consists of a flange-mounted seacock, such as the type with a triangular base, mounted to the hull with a substantial backing block. — *JM*

Moisture Bagging

Add moisture from condensation, humidity and warm temperatures in an enclosed, stagnant area and you have the perfect recipe for mildew. Mildew is disguised as a usually black, sometimes white growth produced on surfaces by molds. Molds are fungi, living plants that thrive in a damp, warm environment. Like a shower room, a boat offers the ideal climate for molds to grow. Optimum temperatures range between 20°C to 30°C (77°F to 86°F), relative humidity from 70% to 93%. (Below 62% humidity, mold growth stops.)

On boats, mildew molds feed on fabrics, painted surfaces, window frames, wood and other surfaces. As molds grow and reproduce, they cause considerable damage.

We discovered Damp Rid (www.damprid.com) Hanging Closet Freshener at a RV store in Florida and purchased a few for our project boats and the basement at home. It's a non-electric moisture absorber filled with crystals that you hang in lockers, vee berths, engine compartments and anywhere there's a build up of moisture. Each crystal absorbs more that twice its own weight in air moisture and in about 8 weeks or so, you have a bag full of water. It makes a great addition to your mildew combat kit.

Measuring PPM

In your article titled, "Water, Water, Just "Pure Water,'" on page 4 in DIY 2003-#2 issue, you state to "fill entire system with a chlorine solution having a strength of at least 100 parts per million (PPM)…," which equates to about one tablespoon of bleach per gallon (3.78L) of water. But how to calculate 100 PPM?

For those who don't what to do the math, DIY Reader Joel Albert of Potomac, Maryland, sent us an easier formula recommended by the

A "condotrailer," add another level and it's a "towntrailer."

Montgomery County, Maryland health department to disinfect drinking water systems.

Use one tablespoon bleach per gallon of water to disinfect. Joel lets it stand for a day but a shorter period might work as well. Flush thoroughly as describe in the article. Thereafter, add 1/2 teaspoon for every 10 gallons (37.8L) of water should keep the nasties away.

No Foul Facts

I saw your poll on bottom paint (page 2, DIY 2003-#2 issue), which reminded me that I've been meaning to write you about a paint I tried on my aluminum Marinette last year. NoFoul ZO, by Epaint (www.epaint.net), gave fabulous results. The company claims its product produces barnacle-killing hydrogen peroxide. For comparison, there were patches of Trilux under the stands that weren't recoated. When the boat was hauled, these areas were covered with barnacles while the Epaint was largely (not completely) free of the nasty critters. It's worth including this product in any comparisons DIY might undertake.

Joel Albert, Potomac, Maryland

There are many variables that affect the success of any bottom paint.

Substrate preparation, paint application, ambient temperature, sea temperature and growth all contribute to a paint's success or failure. Trilux is a hard antifouling, which means it doesn't wear off but does time expire. Life span is nominally a single season. Also, the biocide in this paint oxidizes in the presence of air, so the boat must be launched soon after painting. As you didn't apply a fresh coat of Trilux, it's antifouling properties most likely had expired. A more direct comparison would be to recoat the Trilux as well. However, I'm a great believer that the best approach with any maintenance product is that if it works, use it!

TIP SALTWATER FLUSH

Q: When flushing a Mercury engine, do I run the engine in neutral or in gear and for how long?

A: Your engine service manual has the flushing process covered very well. It calls for neutral gear with the engine run at 1,300 rpm for 10 minutes. During this time you must carefully monitor the coolant temperature gauge to ensure there is no overheating.

— Steve Auger

DIY's Helping Hand

DIY's Technical Helpline is free for all subscribers. If you have a problem, we'll do our very best to help. Below is a sampling of comments from some readers.

"We really appreciate the technical support line. The magazine is wonderful and this service is a fabulous plus! "

Judy Taylor, "Allegro," Minneapolis, Minnesota

"Thank you ever so much for taking the time and energy to respond to my questions I had about my boat's hull repair. You have helped me so much to finalize my approach to the repair-replacement. It has taken me weeks of research and planning before I started this project and your thoughts and suggestions have answered whether or not I'm on the right track. Even though my Switzer was built in 1984, I love this boat and, since I have some knowledge of laminates, I decided to give this repair a shot or the boat may have ended up in the bone yard, which would have been a sad day."

John Renner, Toronto, Ontario

"Thank you for your help! It's really nice to know if I have some type of boat maintenance question, I have someone to ask without feeling embarrassed or stupid about asking the question."

Steven J. Walke, "Kitty," Panama City, Florida

"The only "stupid" question is the one that isn't asked and those who fail to ask are the ones who should be "embarrassed." We all get an opportunity to learn something in the Q & A dialog. "

"Thank you for your assistance with the leaking Volvo transmission. I did, in fact, have the tranny rebuilt because of oil leaking. However, the mechanic, who was highly recommended by an individual in our boating fraternity, did a rather sloppy job and has already replaced one seal that was pinched on the installation. It would seem in talking to people that I'm not the only one to experience shoddy workmanship. You have a great magazine and a great tech service."

Bob Milsom, Sterling, Ontario

"I wanted to let you know that after receiving help from the Technical Helpline on my 1987 Catalina 30's deck delamination, I followed your advice and replaced the core. I removed a 2m by 45.7cm (7' by 18") wide piece on the port and starboard sides. I was pleased with the results. Also impressed were my dock neighbors who told me I was nuts to take on this job. Unfortunately, I didn't take pictures. Thanks for the help. I'll be a faithful subscriber for as long as I'm into boating."

Randy Sherwood, Charlotte, Michigan

TALK BACK Q&A

HELP LINE 1-888-658-2628

The following is a small sampling of the numerous questions DIY receives from its Technical Helpline. If you have a boat maintenance question and are a subscriber to DIY boat owner magazine, the Technical Helpline is free. It's our way of giving something back.

Please send your questions to tech@diy-boat.com. We try to reply within two business days, though it may take longer during peak times.

A Case of Weeping Core

Q: I'm meticulous about keeping the engine room floor (bilge) clean and painted on my 1990 Morgan 44 center cockpit sailboat but I have a stain that appears, seemingly, at random. The weep (limber) hole in the forward end of the engine bed has, in the last several months, deposited a rusty water stain on the

floor, as shown in the attached photos. Typically, I'll leave the boat on Sunday evening and, when I return a week later, there's a dry stain. This occurs only every two or three months. I'm not experienced in engine bed fabrication techniques; so don't really know what's in there.
Dudley Gibbs, Julsa, Oklahoma

A: I suspect you have a case of a saturated core in the sandwich laminate of the engine beds (stringers). Bilge water is migrating into the laminate from hardware not properly sealed or the limber (weep, drain) hole itself and the core has become water soaked. Regardless of the leak source, you now have water in the core and that water can break down the core, separate the core from the fiberglass skins and/or attack hardware that penetrates the core. At some point, that water reaches a saturation point and runs through the core via the path of least resistance, oozing the brown fluid at the lowest point, which is, in this case, the engine bed drain hole. The staining you see could be from rusted bolts that are now constantly wet within the core of the laminate structure or it could be the core itself, weeping the stain as it breaks down structurally and chemically. You must locate the source of the leak and seal it or water will continue to break down the laminate's core and eventually affect the structural integrity of the hull. In the situation you describe, the engine's normal operation and the related vibration dynamics are aggravating the problem. This becomes a more serious concern on balsa or foam-cored hulls. Once the source of the water ingress is isolated and eliminated, you'll need to check the engine mounting bolts and brackets for corrosion damage and, at the next haulout, you should plan on checking the hull and deck hardware and rebedding as needed. Wherever hardware penetrates a hull or deck laminate, there is potential for water intrusion and subsequent core saturation. We recommend that all hardware is rebedded at least every 10 years and spot-checked on new boats. A moisture meter will help to assess the extent of the problem and its source. You might want to engage a competent marine surveyor to do this.
— Jan Mundy

Winterizing Fuel Systems

Q: I read in a DIY back issue about changes in traditional winterization procedures of gasoline engine fuel systems. These changes came about largely, I think, as a result of ethanol in gas. The recommendations, as I remember, were to run carbureted engines dry and add gas mixed with two-stroke oil to fuel injected engines. When I spoke with a Mercruiser technical rep about storing my 1988 Mercruiser 5.7L sterndrive without fuel in the carburetor, he was aghast at the practice. Could you confirm what the latest recommendations are?
David Beach, "Knot Home," Waupoos, Ontario

A: The recommendations remain the same as we published but not exactly as you have stated. [Ed: Step-by-step sterndrive winterizing procedures appears in DIY 1999-#3 issue or on the MRT "Engines" CD-ROM.] Treating fuel systems is a two-step process whereby you first treat the fuel to protect the fuel system components. Then carbureted engines are "fogged" and EFI engines are protected with a pre-

pared "soup." To treat the fuel, remove the boat's fuel source and in a portable tank mix up 1-gal high-octane fuel (the highest available), fuel stabilizer and two-cycle motor oil at a ratio of 24:1 or 1qt to 5gals. Run the engine at idle for five minutes to distribute this "soup" through the fuel system. The alcohol eventually evaporates, leaving detergents and additives suspended in the oil, which are then exhausted

upon starting the engine after lay-up. You now have two choices: drain the fuel tank or fill it full. On carbureted engines, protecting the cylinder walls and piston rings from rust is done by a technique known as fogging. Remove the flame arrestor and, with the engine idling, spray storage seal, a lubricant containing an adhesive propellant (alcohol), which evaporates and leaves a gummy residue that sticks to the cylinder walls, into the carburetors. Continue spraying until the engine stalls due to lack of proper fuel mixture. Never use storage seal in fuel-injected engines. Instead, disconnect the boat's fuel supply, remove fuel-water separating filter and empty the contents. Fill the filter with a 50/50 mix of fuel stabilizer and two-cycle motor oil. Reinstall the filter and then run engine until it stalls. Remove the fuel-water filter and replace with a new one. If your engine is not equipped with a canister-type fuel-water separating filter, mix up a "soup" of premium fuel, two-cycle motor oil and fuel stabilizer. The motor oil suspends additives in the fuel and keeps fuel injectors and the fuel pump check valve from sticking.

— Steve Auger

Outrage at Pump-Out Charges

Q: After damaging (hit a rock) the bottom of my cruiser, I was told by the fiberglass repairer that the fuel tank must be removed in order to do the repair. On the repair bill there was a US$382 charge to "…pump out fuel tank, estimated amount 80 gallons (67L). Note that gas will not be replaced." When I disputed the charge I was told this task was a three-man job: one man to hold the fire extinguisher, one to pump out and one for some thing else which I don't remember. When I asked what happened to the gas, I was told it was given away and that it would have cost me more if I called a waste management service. Is this charge and fuel disposal the usual or am I being taken?

Alfred Mezquida, "La Famílla," Norwalk, Connecticut

A: Gas disposal is a nightmare! There are only two ways to dispose of fuel: give it away or bring in a toxic waste disposal company, which will charge far more per gallon than the gas was worth new. I can't comment on the labor charge but it may be a requirement of the shop's insurance company or a workplace regulation in some jurisdictions to have a dedicated "fire watch" person when handling gasoline. Gasoline is the most frightfully dangerous stuff and most repair shops want to avoid handling it (and so do their insurance companies!). Boaters should expect to pay a premium for any gas handling. Check with your insurance company to see if these costs, as related to the repair process, are covered in your policy.

— Nick Bailey

Troubleshooting Ignition Switch

Q: How do I test an ignition switch?

Jose Perez, "Seawolf," Miami, Florida

A: Most carburated outboards use the ignition switch to control the ground side of the ignition. This means that if the key is in the "off" position it grounds the ignition lead. If it's a "no spark" condition (terminals are marked with "M" on ignition switch), on smaller outboards you can disconnect the wiring harness to the key switch and use the manual coil starter. On larger outboards, disconnect the wiring harness and use a remote starter switch attached to the starter solenoid. If the motor starts, there is a short within the key switch or wiring harness. Be aware that the lanyard safety kill switch, if equipped, is also tied into the ignition and must be temporarily disconnected before troubleshooting. If it's an EFI or Optimax (direct fuel injection) engine, have it serviced by a dealer so you don't fry the $2,000 engine control unit (ECU). If it's a "no crank" condition, the key switch takes battery voltage and sends it to the starter solenoid. Have someone hold the key in the start position and check for voltage on the "S" terminal of the starter solenoid. If there is power, there's a problem with the starter or solenoid. If there is no power, the fault is in the key switch or wiring harness. As always, referring to a service manual will prevent destroying more systems than you are attempting to fix.

— Steve Auger

Polarity Indicator Mystery

Q: When I'm at anchor using the generator, occasionally a reverse polarity light comes on the AC control panel. There are 50 amps coming into the boat with two separate circuits. The light activates on only one circuit at a time. If I have both switches on "gen" only one warning light comes on. If I turn off one circuit, the light comes on for the other. Sometimes it just flickers and it doesn't matter if there's a load on the circuit. It never happens when plugged into dockside power.

Bob Long, "Ariel," Port Washington, New York

A: There is a situation where false reverse polarity indication is given. This applies to LED-type indicators with a resistor inserted in one leg of the LED. This may occur when voltage drop increases causing the LED to faintly glow. The causes are usually due to wiring being under rated for the load, either from shore or on board. It may also be an indication of a bad connection increasing the voltage drop. In some cases, this may be either to the ground connection or the neutral connection. Your first task is to turn everything off and examine and tighten every connection. Then check that all ground points are correct. Perhaps the generator safety ground wire is not properly attached to the boat ground anymore. Based on the information, it's possibly generator-related connections that have to be examined. When something just starts to occur, usually something else is degrading.

— John Payne

Fuse links

Q: I'm changing battery chargers and the install information requires a breaker and disconnect or a fuse disconnect on each positive cable going from the battery charger to each battery. These are AWG 6 and I cannot find a fuse, maximum 25 amp, for this wire size.

Robert E. Rayburn, "Georgie Girl," Catabwa Island, Ohio

A: Complete instructions for selecting the type and size of fuse or circuit breaker for an electrical circuit appears in DIY 2002-#2 issue. Your choices are limited to the Blue Sea 5006 MAXI Fuse Block, rated at 80 amperes maximum and 32 volts DC, or a Blue Sea 7000-series thermal circuit breaker that has a 3,000 ampere DC interrupt rating and 30-volt DC rating. Where circuit protection installs in a gasoline engine compartment, battery or propane locker, you require the T-1 series. These breakers are available with ampere ratings from 25 to 150, a DC voltage rating of 48 volts, and 5,000 amperes at 24-

volt DC interrupt rating. Check if your local chandlery will order this part for you or log onto the Blue Sea website at www.bluesea.com.

How to Paint Arborite

Q: I have just purchased an Allied Princess with large vertical expanses of simulated teak arborite. I would like to paint this white to transform the cave-like interior. How do I prepare, prime and paint this surface?
Brian Bishop, Goderich, Ontario

A: While I have not painted Arborite, I have painted Formica and the steps are essentially the same. To begin, clean well with soap and water using a stiff brush or Scotch-Brite pad. Wipe with Interlux 202 or 216 thinner (or similar) to remove all surface oil or wax residue. Sand with 120-grit sandpaper. Because you are going from a dark to a light color, you'll need to apply a primer. Use Prekote if you are using Brightside or Toplac and Epoxy Barrier-Kote 404/414, if Interthane Plus is the choice for the finish. Sand the primer with 220-grit paper. Wipe down to remove the sanding residue and apply two or three coats of finish. You could use a yacht enamel but, for a lower gloss finish, I would use the Toplac or the Interthane Plus with the flattening agent (4317 for Toplac, 2317 for the Interthane Plus) simply because they stay whiter longer indoors than does Brightside or other single-part polyurethane paint. If you were using any color other than white, it doesn't matter.
— Jim Seidel, Interlux

Running Radar Interference

Q: Whenever I run my old Furuno radar with an open antenna and Garmin GPS, the GPS loses its signal. The radar antenna is mounted approximately 61cm (2') forward of the GPS receiver on the flybridge hardtop. Raising the GPS receiver on a 61cm (2') extension didn't help. I see other boats with this arrangement and don't know why mine does not work.
Daryl DeLullo, "SavannahSam," Boca Raton, Florida

A: There are three different issues here. One is where a GPS antenna is mounted close to or within the beamwidth or output of the radar scanner. It's always recommended that antennas clear outside the transmission beam. The second is that the rotating scanner may be physically blocking or inferring with the visibility of some satellites and, to avoid obscuring, the antenna must be mounted well clear so it has a clear horizon. The third issue is that when radar is switched on there may be induced interference from radar cables to the GPS antenna cable. This is often overlooked so you should look carefully at the cable routings and

rearrange if close. This may actually be a problem given that physical relocation has not altered things. In addition, look at radar and GPS grounds and ensure they are actually connected and to the same ground point.
— John Payne

In-Hull or Thru-Hull?

Q: I've read a lot about thru-hull versus in-hull transducers and now I want your opinion. I prefer in-hull for obvious reasons and hull bubbles should not affect my trawler-type displacement boat.
Stephen Camp, "Argo," Greece

A: It's technically possible to mount your depth sounder transducer inside of uncored fiberglass hulls in a tube or chamber filled with non-toxic antifreeze (water only in southern climes), castor oil or even in a blob of silicone sealant. Such installations will avoid the dreaded hole cutting and reduce drag, especially on high-speed powerboats, but don't expect top performance from your sounder, especially in deep water. Inside transducers won't work with cored hulls or even solid fiberglass ones if air bubbles or voids are present in the lay up. You'll have to locally cut away the core and inner laminate. This may compromise the structural integrity of the hull, so don't do this without consulting a surveyor or boatyard. Antifouling on the outside of the hull may also negatively affect the instrument's accuracy. On the plus side, a transducer mounted in the bilge is easily accessible for repair or replacement. Having said this, Airmar (www.airmar.com) offers a "smart" in-hull transducer, the P79, designed specifically for fiberglass hulls. It apparently overcomes the problems of signal loss caused by trapped air bubbles and beam bending to compensate for deadrise.
— Jan Mundy

Some Slick Coating

Q: I have what I thought was peeling Vertglas on my hull. After scrubbing with the recommended remover and then floor stripper followed by MEK and getting nowhere, I have determined that it must be a different coating. Someone told me about a Teflon coating that was sprayed on to make a hull look new. Is it possible to remove this? Am I stuck with a peeling coating for the next several years?
William Hundley, "Reel Love," Baltimore, Maryland

A: It's highly unlikely that the coating is Teflon, more likely a clear-sprayed finish. It appears you have two options: paint stripper or sanding. The concern, of course, is to minimize gelcoat damage. It was suggested that you first try pure methylene chloride but this is nasty stuff, as is the MEK, which I'm sure you've already discovered, so I don't recommend it. Instead, apply Interlux Interstrip (which doesn't contain this solvent). It is apparently safe for use on fiberglass, nevertheless, I would first do a spot test in an inconspicuous area. Follow the application instructions carefully to avoid gelcoat damage. If this doesn't work and I suspect it will, you'll have to go the mechanical route. Begin sanding with 220-grit paper and go coarser only if it's not removed. Use sandpaper for metal abrasives to reduce plugging of the paper. One way to test for Teflon? It's difficult to sand and very, very slick. If it's Teflon, you'll need bundles of sandpaper.
— Jan Mundy

Mating Jabsco with Raritan

A: I own a 2000 Harbormaster 52 Widebody that has Jabsco designer series toilets, models DS14 370752. I want to hook a Raritan Purasan waste treatment system to these MSDs. Do you have any suggestions on how to do this?
George Hillebrand, "Get Over It," Edwardsville, Illinois

Q: According to a senior technical advisor at Raritan Engineering, the Purasan is only configured and U.S. Coast Guard certified for use in conjunction with a Raritan toilet. Three models are acceptable for its use: the Atlantes, Crown Head and Crown Head II. However, Raritan manufactures another certified Type I MSD, the Lectra/San MC, which requires the addition of salt to the flush water. The saltwater is converted electrochemically into a bactericide that reverts back to salt water once the process has been completed. The Lectra/San MC will work with your DS14 series Jabsco toilet. A step-by-step install of the Lectra/San appears in DIY 2002-#1 issue. Also, log onto Raritan's website at www.raritaneng.com for more details and information regarding the Lectra/San and its process. Both the Lectra/San and Purasan systems are Type I MSDs, which are only legal for use in areas of water not declared Federal no discharge zones and only on boats up to 20m (65').

TECH TIPS

A HELPING HAND: When installing deck hardware over the foredeck or aftcabin, use extra long bolts that pass through the deck, a backing plate and add a custom wooden handhold and secure with cap (a.k.a. acorn) nuts. Use this new handhold on the underside of the deck to pull yourself through, in this case, the vee berth.

Sandy Turney, "Sandy's Beach," currently in Brunswick, Georgia.

HEAT 'N PEEL: To remove old faded vinyl boat names or boat registrations (not painted) use a heat gun or hair dryer. Apply just a little heat while hand peeling off the graphic. Remove any residual glue with 3M General Purpose Adhesive Remover, then apply rubbing compound and Finesse-it to restore the gelcoat finish. [Ed: having tried the heat-and-peel technique, I still prefer using a Ferro Stripe Eliminator for this job.]

Craig Smith, "Norumbega," Kittery Point, Maine

LAVENDER FRESH: To prevent condensation and mildew when you're away from your boat, fill small plastic containers (e.g. yogurt or cream cheese size) about half full of silica sand available at most craft or hobby stores (US$9 for 450 gram/1 lb bag). You'll need about eight containers for a 9.7m (32') boat, placed in the vee birth, head, bilge, galley, engine compartment, under sinks and anywhere that moisture might be a problem. Purchase a medium size bag of pot pourri, and place that around the boat in four pie tins. The silica draws moisture out of the air while the Pot Pourri leaves a pleasant fragrance in the boat. You can reuse the silica every year; just buy fresh pot pourri.

Paul Murphy, "Taboma Too," Severn Boat Haven, Ontario

NAILED AWLGRIP: Sometimes the chemical method of undoing a small, accidental spill is not a best choice. I dripped a dime-size spot of white Easypoxy on a recently Awlgrip painted hull and was able to remove it by lightly scraping it off with my fingernail and wet sanding with 400-grit paper.

Steve Walke, Mary Esther, Florida

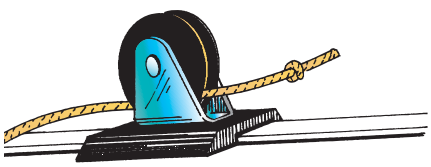
CRUISERS' EYEBROWS: If water drips down from the cockpit or flybridge and stains the cabin windows, install stick-on "eyebrows" available at www.marinegutters.com. Made of plastic and fitted with 3M weather-resistant adhesive bonding tape, these gutters are easily cut to size, bend around corners effortlessly and attach without screws.

BELT TUNE-UP: V-belts, especially those driving high-output alternators, are often overworked. A slight amount of slippage can glaze belt sides resulting in low output. Besides the visual evidence of the black dust residue that indicates belt wear, you can also check for wear by gripping the alternator pulley with both hands and trying to turn it. If the pulley turns, adjust or replace the belt. Make sure the engine ignition is off before doing this test.

George van Nostrand, "Dream Catcher," Keswick, Ontario

IF THE SHEET FITS: To tell if your jib sheets are too small, tie a figure eight knot in the end of the line and if it pulls through the sheet block, it's too small.

Rob MacLeod, author of "From Landfalls to Legacies"



SAIL CLEANER: To remove rust, mold or blood from nylon or Dacron sails, apply a very mild oxalic acid solution, let it sit for about 30 minutes, then rinse off. Do a compatibility check in an inconspicuous area first.

HEAT TO FIT: When you need to remove a plastic hose that refuses to separate from a hose barb or install a new one that appears too small to fit the hose end, use a hair dryer to apply enough heat to soften the hose end.

TELLTALE SMEAR: When cleaning windows, clean the inside by moving the rag in a back and forth direction. Clean the outside in an up/down motion. If you have smear, you be able to tell which side of the pane it's on by the direction of the smear.

Jim Adams, Orillia, Ontario

REMEMBER THE THRU-HULLS: Next time you haul out for bottom painting, use a small paint brush and paint as far as the paintbrush will reach inside thru-hulls to prevent sea life from growing inside the fitting.

TECH TIPS WANTED

Do you have a boat-tested tip or technique? Send us a photo (if available) and a description, your name, boat name and homeport and mail to:

DIY TECH TIPS
P.O. Box 22473
Alexandria, VA 22304

Or email it to info@diy-boat.com

Reader tips are not tested by DIY, but we won't publish anything we feel might harm you or your boat.

PRO SERIES

Bristol Marine Gallery of Collision Repairs (clockwise top left) Viking 34 with crunched hull, deck and toerail, bent bow rail and compression fracturing of deck; C&C 25 with hull, deck and toerail crunched; Dufour 38 has punctured hull amidships starboard side, damaged toerail and cracked deck; C&C 35's hull torn open amidships starboard side, interior deranged and broken bow casting from a rampaging Beneteau still embedded in the hull; C&C 27 received a punctured port bow, bent toerail, fractured deck and damaged interior.

CLOSE ENCOUNTERS

The physics are inevitable. When a fiberglass boat sails into an immovable object or another boat underway, the "glass" and anything attached to it will surrender to the impact. Read on to see how a professional service yard rebuilt five badly damaged boats.

STORY BY NICK BAILEY.
PHOTOS COURTESY OF BRISTOL MARINE.

Collision repair is a staple of any marine service yard in an area with a large sailboat population. Sailboats collide with other sailboats but the speed at impact is relatively low and damage is usually limited to property. Powerboat collisions, because of the relatively high speeds at impact can elevate the consequences to create work for salvage companies, lawyers and, tragically, sometimes the coroner, rather than the repair yard.

Repair and replacement of toerails, as discussed in DIY 2003-#2, is often just the beginning. Punctured topsides, cracked decks, crushed hull-to-deck joints and deranged interiors are not uncommon. Deck hardware damage ranges from broken lifelines to complete dismasting.

Phase 1 Damage Assessment and Estimating

Insurance companies claim departments have specific procedures that apply to handling a claim for damage cost reimbursement so make sure you know your rights and responsibilities under your insurance policy contract. The company will, very likely, assign a marine surveyor to assess the damage and to be their "eyes" in the process. In a major collision not all damage is immediately obvious so some preliminary work may have to ensue to determine the full extent of the damage prior to finalizing the estimate. The first priority and responsibility you have, as the insured, is to make sure the boat is protected from further damage. That may mean the boat needs to be hauled out of the water and put under cover. Obvious damage is relatively easy to define but interior removals may be required to gain access to obscured damage and to make sure the damage is fully assessed. There may be other destructive work needed to ensure that all damage that may be beyond the obvious point of impact is identified.

Dufour 38: Core exposed at hull puncture creates danger of water entry into core.

Finding Hidden Damage

Stress cracks in gelcoat are a bugbear in collision repairs. When fresh, they are often nearly invisible and result from glass laminates being flexed but not obviously damaged in a collision. Some "blunt trauma" collisions (such as when two boats bump together heavily while traveling side by side) may show little obvious impact damage but a year later the resulting stress cracks have picked up enough dirt to become plainly visible over a large area. A hole at the hull-deck joint, resulting from a 90°, "T-bone,"

left) Viking 34: Sometimes stress cracks are hard to spot. This photo represents about 1.8 square meters (2 square feet) of hull, .6m (2') below the impact point. (right) Other stress cracks are easy to see but may just be the tip of the iceberg.

type collision may appear to have been successfully repaired but next season multiple stress cracks appear through antifouling paint and well below an/or surrounding the point of impact. Painted boats are a particular problem for it can take months for cracks to work their way through the paint. In such cases, the insurance company will be asked to reopen the file and repair the hidden damage. It's far better to determine the extent of the damage prior to any repair effort.

Deck hardware and rigging is another area where damage can be subtle. Lifelines are very strong and transfer a lot of load to the bow and stern rails in a collision. If the lifelines and stanchions have been wiped out it's common for the bow and stern rails to be distorted. Anytime standing rigging is damaged, the mast should be unstepped for careful inspection. The mast step and related support structures should also be checked for damage from compression and stress loads transmitted by the mast.

Bulkheads do shift, secondary bond tabbing can delaminate and interior modules can undergo subtle relocations. Complaints such as "The head door is jammed shut" or "I can't get the lid off the icebox" give clues. All these things require very careful examination. A pro will look below and adjacent to the impact for hints of stress cracks that show only under specific lighting conditions. Seams and joints in the interior get checked for signs of movement. Tabbing at bulkheads, stringers and liners are checked for delamination. It also helps to provide the repair shop with a complete damage list. The shop (and the surveyor) may have no idea that the eight-track stereo, the late '70s VHF, vintage Loran and Atomic 4 all stopped working because of the collision shock!

Phase 2 Prep

Once a repair is authorized all of the damage assessment described above usually proceeds at the same time as the boat is prepped for repair. If the work requires significant glass repairs, it's important to remove or relocated cushions and all personal gear in dust proof bags or other dust barriers that can be taped in place in the cabin. Next, any damaged hardware such as toerails, stanchions, jib tracks, pulpits, etc., are removed for repair or replacement. If the hull (or deck) has been holed, it's best to do the glass repair from both the outside and inside.

Grinding fiberglass inside requires protecting the interior with a dust barrier of plastic sheets.

Sometimes the bow of the colliding vessel penetrates far enough to damage the interior of the "collidee." This demands carefull dismantling and removals of interior joinery as required for either access or repair. Interior work can present difficulties. Boat interior furnishings are commonly prefabricated as modules and installed before installing the deck. The builder never planned on their removal. Where fasteners are not accessible, careful cutting is required. These conundrums require compromises that mean extra moldings and trim to

(top left) C&C 25: Impact came close but did not dislodge shelf in V-berth. (top right) Dufour 38 was not as lucky. Note broken mahogany inner liner and cracked glass headliner. (bottom) C&C 35 suffered shifted shelving, bulkheads and broken interior trim.

cover necessary surgery and extra labor. If it proves completely impractical to access the inside skin it's possible to do an adequate outside-only glass repair, but this option is not the first choice.

Phase 3 Structural Repairs

Once full access to the glass damage has been gained glass repairs begin. By now, the surveyor's technique of percussion sounding (tapping with a hammer and listening for the distinctive sounds that indicate changes in the laminate structure) has been used to determine how far delamination extends

(top) Dufour 38: Where practical, damaged upper laminate and core is removed and inner layer preserved as a base for rebuilding the laminate; (left) C&C 27: Deck core and upper laminate are cut back to sound material; deck flange is damaged beyond salvage.

beyond the obvious point of impact. Sometimes, this method of non-destructive damage detection is inadequate to the task and other, more sophisticated equipment is required, such as infrared imagery. This perimeter is marked with a grease pencil and an air-powered diamond–edged cutting disc (or a jigsaw, carbide circular saw, Dremel tool) is used to cut away the damaged glass skin. If liners or joinery are still in place behind the damage, care is taken to not cut any deeper than needed. In the case of damage to a cored laminate the outer skin and debonded core is cut away and as much of the inner skin as possible is preserved as a base for rebuilding the laminate.

The cutout removes any severely delaminated glass; however, outside this perimeter, there remains a region of stressed glass that has been flexed heavily and micro-fractured. This is where the stress cracks, currently not detectible, will inevitably appear. This damaged, but not delaminated area can be large if the hull is an easily flexed molding. An angle grinder with a 36-grit disc removes gelcoat from the area surrounding the cutout to reveal the condition of the laminate. If any whitish areas indicating fractures or subtle delamination are visible in laminate, additional grinding is required to remove the damaged glass. In this manner, the perimeter of gelcoat removal is extended outwards until sound laminate is exposed. Gelcoat stripping can extend from a few centimeters (inches) to a few meters (yards) wide.

(top) Viking 34: Grinding away damaged glass. Note exposed core. It better not rain. (bottom) C&C 25: Removing deck laminate — see the dust fly!

The next step involves grinding the exposed laminate around the perimeter and feathering it to a tapered bevel. This provides a scarfed bonding surface for new laminates. The minimum scarf length is no less than six times the thickness of the laminate; for example, a 3.8cm (1.5") scarf for a 6mm (1/4") laminate thickness. Larger scarf ratios, 12:1 to 20:1, are preferred for the best bond strength, especially if the boat is built with modern DCPD (dicyclopentadiene) polyester resins. In practice, if the perimeter band of stripped gelcoat is quite wide, the scarf ratios of the repair end up being huge, which is a bonus. When repairing smaller puncture holes, the old guideline of keeping the scarf to at least half the hole diameter applies. Where access to the inside is possible, the inner surface receives a shallow bevel or is, at least, roughed up with coarse sandpaper. Usually, only a few layers go on the inside.

C&C 25: After prep grinding, the repair is ready for new glass lay-up. Note beveled edge, which represents a scarf ratio ranging from 8:1 to 12:1 for this 6mm (1/4") thick hull.

(top) C&C 25: Glass lay-up. Note the hull and deck flange is kept separated so the vinyl rubrail can be reinserted. (bottom) Dufour 38: Note new PVC core just visible through the new laminate. (top) C&C 27: Large overlap around location of original hole dictated by extensive stress cracking.

Once the repair area is fully ground, it's blasted with compressed air and wiped with acetone to remove dust and any contaminates. Masking paper (or 3M Ready Mask) is applied to protect the hull from resin drips.

Any hole repair requires a backing attached to the inside of the hull to act as a plug and contact mold. Formica works well in this application. If the only access is outside, then an insertable plug is needed. This consists of a piece of cellophane covered cardboard 1.5 times the hole diameter with a wire threaded through the center as a handle. A dry piece of fiberglass material is cut the same size as the cardboard and is placed on top of the cardboard plug and also threaded through the wire. The glass is wetted out with resin, the plug bent and inserted into the hole, then held in place with the wire until it cures. After the plug cures, the wire is cut off or pushed through into the boat.

Now layers of mat and roving, roughly duplicating the original laminate stack and any replacement core materials are sized and cut. Beginning with the smallest patches first and proceeding to the largest, maintains a multiple bond line between the new and old layers.

Glass lay-up proceeds in the usual way with care being taken to chase out air bubbles. Any core is dealt with first and allowed to cure before the outer lay-up begins. [Ed: see deck repairs in previous issue]. It's common practice to lay multiple layers at once, though allowing each layer to cure before applying the next achieves the best quality.

Dufour 38: Chasing bubbles out of a (relatively) small glass repair on a deck flange.

The last two layers are 1.5 oz mat. This prevents cutting into the roving or other material when sanding and fairing the new patch.

Any boat constructed using vacuum bag technology and advanced composites, such as epoxy resins, thin exotic laminates and thick cores, utilize the same repair methods. A vacuum bag is also helpful applying clamping pressure to an overhead lay-up.

Fiberglass repairs to interior bulkhead tabbing, etc. are technically straightforward. Just grind off the delaminated tabbing and lay up

C&C 35: Broken tabbing in a hanging locker.

new tabbing but working in a hard to reach location makes it tricky.

Phase 4 Cosmetics

Using a 1,500-rpm, 20cm (8") sander-polisher the glass patch is leveled for application of fairing putty. In many cases, the filler is simply gelcoat thickened with colloidal silica but below the waterline a vinylester or epoxy putty is preferred for better durability. Shops use blue dye, long boards and sanding blocks to create a smooth shape.

Each filler application uses a finer (less viscous) compound to fill fine pinholes and air bubbles. The final sanding uses 150-grit sandpaper. [Ed: detailed filling and fairing procedures appears in "18 steps to a Smooth Finish," in DIY 2003-#1 issue.]

(top) Filling and fairing: First fill on Dufour 38 ready for sanding. More fills will be needed. (bottom) First fill on C&C 27 repair.

(top) Dufour 38: After spraying and cure, new gelcoat is dry sanded initially up to a 400-grit finish with a dual-action sander. (middle) The repair is then block sanded by hand with progressively finer wet sandpaper up to an 800 or 1,000 grit finish. (bottom left) Finally buffed to a gloss with polishing compounds. (bottom right) 3M Marine makes a full range of polishes for each stage of the process.

Where the boat has a white gelcoat finish, the final gelcoat topcoat can be color matched successfully. Gelcoat is sprayed on, then wet sanded and buffed to a high sheen. If the boat was once a bold gelcoat color that has now faded, there is no hope of an exact color match and the repair will be obvious. Some insurers will take this into consideration and may allow repainting but don't be surprised if you're faced with the limits of policy provisions that reference "betterment." If your insurance company allows, painting one side of the hull usually costs 67% of the full price and most people are pleased to pay the remaining 33% and come away with a spectacular paint job. If the boat has a painted finish, the repair is primed with two or three coats of an appropriate epoxy primer, fine filled, sanded with 320-grit paper and painted with a two-part polyurethane. This is buffed and blended to match the rest of the hull. Even in this case color match issues often arise and it's sometimes best to prep-sand and recoat the entire side.[Ed: for more information on painting hulls refer to "10 Steps to a Perfect Paint Job" in DIY 2002-#2 issue.]

New "stucco" style deck anti-skid applied by roller on the C&C 25.

(bottom) New tubing is cut and shaped for fit prior to welding. (left) Welding stainless steel is followed by careful polishing.

Repairs on deck non-skid areas have their own issues with matching an existing non-skid pattern. [Ed: deck refinishing options appears in DIY 2002-#4 issue.]

Phase 5 Hardware Reinstallation

Albeit the boat's structure is now repaired and refinished, in many collision repairs there may be still lots to do. Stainless steel bow and stern rails often require straightening or rebuilding with careful cutting and welding of stainless tube followed by hours of polishing. In some cases, it's worthwhile to buy a new pulpit rather than rework an existing one. Lifelines and stanchions that have been severely stressed are always replaced.

Toerails always take a beating and repairing them is an art unto itself. [Ed: refer to DIY 2003-#2 issue for how to repair aluminum toerails.] Vinyl rubrails have their own family of repair materials and are amenable to filling, fairing and painting. New sections of teak caprail often need to be created and scarfed into place. All of these items must be refastened and rebedded before the job is done to say nothing of launch, rerigging and cleaning, all at professional labor rates.

(left) A broken vinyl rubrail is rejoined and bonded together in the hull-to-deck joint on the C&C 25. (right) Gouges in vinyl can be filled, faired and painted using special vinyl repair products.

When properly done the repair work should be seamless and nearly invisible. Resale value should remain intact and the repair should survey with flying colors.

About the author: Nick Bailey has spent 25 years in the boat repair business and is service manager of Bristol Marine in Mississauga, Ontario.

Damaged areas of teak caprail are replaced by new teak glued and scarfed into place and then given the necessary multiple coats of varnish.

A new toerail is bent and fastened into place with lots of sealant.

C&C 25 hull repair after priming. Ready for final sand and polyurethane painting.

C&C 25: After painting, launch rerigging. Hull still needs a final buff to blend in the edges of the repair.

Opportunities in a Write Off

(Don't Fear the Reaper)

What happens when the repair costs are too high? If you were unfortunate enough to be dismasted or sunk in a collision or have some other large-scale disaster befall your boat, it's not uncommon, especially with an older boat, to find that repair costs exceed the value of the boat.

When a repair quote approaches the net payout of the insured value, less the amount the insurance company can recover by selling the wreck as salvage, the insurance company calls it a "constructive total loss" and writes off the boat. You receive a check for the insured value from the insurance company. If you are a skilled and dedicated do-it-yourselfer, you may find it worthwhile to buy the boat back from the insurance company and do your own repair. The insurance money may not pay the cost of a professional repair but it may cover your costs and then some. There might even be enough left to have critical items done professionally while you look after the rest. In this situation, always have the boat surveyed by a marine surveyor before undertaking the repair and continue consulting with the surveyor during and after completing the repair. —*NB*

ENGINE TROUBLE SHOOTING

OIL TEST: TROUBLE-SHOOTING WITH OIL ANALYSIS

Oil analysis is the most valuable tool you have to discover problems before they result in major damage or failure to your gasoline or diesel engine. Learn what oil analysis includes, how it relates to potential failure and how to properly take oil samples.

STORY AND PHOTOS BY LARRY BLAIS

For many years fleet operators have used oil analysis to discover developing internal problems in engines before they suffer major damage or failure. Boat owners and even perspective boat buyers are finding that they too can benefit from oil analysis.

A Spectrometer, such as an Atomic Absorption Spectrometer, an Inductive Coupled Plasma Spectrometer or a Direct Current Plasma Spectrometer are used to detect wear metal particles less than five microns (a micron is one millionth of a meter). Aluminum, chromium, copper, iron, lead, molybdenum and tin are the primary troubleshooting wear metals. It also detects silicon, sodium and zinc. (See sidebar, "Data: Wear Metals" on page 21.)

Wear often occurs when the oil itself has deteriorated due to depletion of its additives or has become contaminated from outside sources. An instrument called a Fourier Transform-Infrared Analyzer (FT-IR) focuses a beam of light through a film of used oil and compares the light transmitted at certain wavelengths to those of the same oil when new. To receive the greatest benefit from this test, a sample of unused oil saved from the same batch as was drawn from the engine is sent to the lab to be used as a reference in the analysis. An FT-IR can detect soot, oxidation, nitration and sulfonation.

The rate that soot (partially burned fuel) accumulates in the oil indicates the quality of combustion in the engine. A rich fuel-to-air mixture, low compression, low running temperature or fouled injector(s) will accelerate the accumulation of soot in the oil. Excessive soot degrades and thickens the oil and will lead to bearing damage as well as accelerated piston, ring and liner wear.

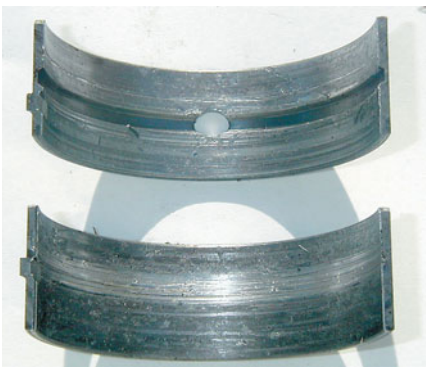
Oxidation and nitration normally increase at a steady rate throughout the life of the oil. Excessive oxidation or nitration may indicate that the optimum drain interval has been exceeded. If the oil is still fairly new, it may indicate higher than recommended operating temperatures or overheating. Oxidation and nitration of the oil increases its viscosity and leads to plugged filters, lacquering, piston deposits, ring sticking and bore polishing.

Sulfonation relates to the oil's alkalinity reserves, measured by Total Base Number (TBN), and the oil's acidic property or Total Acid Number (TAN). The TBN indicates whether enough of these additives remain to protect the engine from acid formation and the TAN indicates the relative level of acid formation. Rapid alkalinity reserve depletion and acid formation can result from high air humidity, low running temperature and/or high idle time. Corrosive acids formed during engine operation can etch metal parts causing rapid wear.

The FT-IR instrument also scans

Very high aluminum levels in the oil helped determine how badly this engine was overheat damaged when the raw-water pump drive belt broke.

High lead and tin levels in the oil showed the extent of the damage to the main bearings after this engine ran low on oil when the hose to the oil cooler failed after chafing on the oil filter bracket.



High iron, lead, tin and oxidation levels predicted the debris damage to this main bearing and its cause. Several camshaft lobes distempered from friction and wore flat because the oil broke down after a worn-down raw-water pump impeller cam caused the engine to run at an elevated temperature.

for the presence of water, glycol (antifreeze) and fuel. If the possibility of any of these is indicated, a separate physical test is performed for verification.

Water sometimes contaminates engine oil through a leaking gasket or seal. However, low running temperature can allow condensation of combustion blow-by gases (mostly H_2O steam that passes from the combustion chamber past the piston into the crankcase). Exhaust elbows that are too low to the waterline in wet exhaust systems and water lift muffler equipped systems lacking an anti-siphon vacuum break are far too often a source of water contamination.

DATA: WEAR METALS

Aluminum originates mostly from pistons; however, it also can come from the overlay of the crankshaft and camshaft bearings. Aluminum should not exceed 15 parts per million (PPM) in most marine engines during the normal life of the oil.

Chromium wears from piston rings, and ball and roller bearings. Chromium should not exceed 15 PPM in most marine engines during the normal life of the oil.

Copper normally leaches from the oil cooler core especially during periods of dormancy. A much more serious source of copper is the underlay of main bearings and rod bearings. Other sources of copper are wrist pin and rocker arm bushings, turbocharger shaft bushings, and oil pump drive. Copper should not exceed 25 PPM in most marine engines during the normal life of the oil.

Iron is a wear metal from cylinder liners, piston rings, oil pumps, crankshafts, gears, camshafts and several other parts of the valve train. Iron should not exceed 100 PPM in most marine engines during the normal life of the oil.

Lead comes from the overlay on main bearings, rod bearings, and camshaft bearings. Lead should not exceed 25 PPM in most marine engines during the normal life of the oil.

Molybdenum comes from the top piston ring on some engines. Molybdenum should not exceed trace amounts, however greases containing molybdenum may find their way into the oil.

Silicon in a special form is used as an oil additive to retard foaming of the oil. Silicon in the form of "dirt" should not exceed 15 PPM in most engines during the normal life of the oil.

Sodium in a special form is used as an oil additive. Sodium as a salt is found in antifreeze and saltwater and may indicate a coolant leak or wet exhaust system problem.

Tin can come from the overlay on main bearings, rod bearings and camshaft bearings. Tin should not exceed 15 PPM in most marine engines during the normal life of the oil.

Zinc is an oil additive and often exceeds 1,000 PPM in better oils.

Glycol contamination of the oil indicates an antifreeze coolant leak. Pressure testing the cooling system may reveal the location of the leak.

Fuel contamination of the oil indicates a fuel system problem such as a leaking fuel injector(s) or a ruptured diaphragm in the fuel supply pump. Fuel dilutes the oil reducing its viscosity and lubricity resulting in bearing damage and accelerated piston, ring and liner wear.

Sampling Formula

To get the greatest benefit from oil analysis there are four things you need to do. First, provide all the information about the engine as requested on the sampling label. The make and model, the hour meter reading, hours on the oil and the brand and weight of the oil are critical for a complete analysis. The date the sample was taken is also important. The serial number helps determine the vintage of the engine and identify the engine for trending with later sampling. Was any make-up oil added that would affect the analysis? Was the filter and/or oil changed at time of sampling? Don't forget to include the boat's identity and contact information. If the boat has more than one engine, identify which engine the sample is from. Filling out the label before taking the sample may help keep the label clean.

Take oil samples at regular intervals. As the number of samplings increase, chart the results to find trends that would indicate trouble.

Use oil analysis to help determine the most cost-effective oil change interval for this particular engine.

Lastly, use oil analysis to discover problems, then confirm the source(s) through further testing and inspection before they result in major damage or failure. Exhaust smoke, fuel consumption, loss of power and internal noises can help to establish engine problems. Oil analysis should not have to be used as the sole indicator of trouble.

Other Fluid Checks

Engine coolant analysis can be quite helpful in discovering engine problems such as a leaking oil cooler, an air leak into the coolant, defects in electrical ground connections, spent metal pitting protection, leaking head gaskets and destruction of iron, copper and aluminum components.

Marine gear fluid analysis can detect impending failure from several sources including overheat, excessive wear and water intrusion. Hydraulic fluid analysis helps discover system wear and possible damage. Diesel fuel analysis can reveal a microorganism infestation and other contaminates.

Many laboratories offer all these analysis and generously provide help to those needing these services. For diesel engines, I have found the Caterpillar dealerships that operate Cat's S-O-S program to be especially helpful.

(left) Elevated iron, lead, tin and copper helped discover the bent rod that this engine suffered when water intruded through a poorly installed exhaust system and hydraulic-locked the piston when it was started. (above) Note the wear pattern into the copper layer of the bearing. This is due to the rod being bent and is called radius ride.

Oil that tested positive for water, glycol and high levels of sodium revealed the perforation of this cylinder wet liner from corrosive pitting that allowed coolant to leak into the crankcase.

The engine containing the top main bearing tested positive for water and showed elevated lead and tin indicating excessive bearing wear. If it hadn't been caught and the source of water repaired, this bearing would have worn until it looked like the bottom bearing. The engine containing the bottom main bearing was showing elevated copper after the overlay was worn away exposing the copper. If this problem had not been discovered, the prospective buyer would have unknowingly purchased a vessel needing extensive repair.

About the author: A master mechanic, master shipwright and marine surveyor, Larry Blais has operated boatyards for more than 30 years. He teaches classes for the United States Coast Guard, Havorn Marine Survey and Shipwright's School, University of Washington's Sea Grant program and hosts workshops in diesel care for the Northwest School of Wooden Boatbuilding.

TAKING AN OIL SAMPLE

Vacuum extraction is the recommended method of taking an oil sample if the engine is not equipped with an oil sampling probe valve. This valve allows insertion of a probe while the engine is running. The engine's oil pump pumps a metered amount of oil through the probe into the sampling bottle. With vacuum extraction, a length of plastic tubing is inserted into the oil sump (usually down the dipstick pipe). The vacuum created in the bottle by a hand-operated vacuum pump draws oil up the tube into the sampling bottle.

Never take samples from the drain stream, the waste oil container or the used filter as doing so usually results in an unrepresentative sample. Don't take samples from a cold engine, as wear components tend to settle over time. Run the engine until it's warm (usually 15 minutes is sufficient) to assure that the oil components and any contaminants are thoroughly mixed and in suspension.

Supplies needed include a sampling kit, a vacuum pump, a length of clean tubing, and a tubing cutter. The sampling kit typically includes a sampling bottle, "New Oil" bottle, identification label and shipping cylinder. All supplies are readily available from an oil analysis laboratory.

Step 1

Mark the new tubing to the length of the dipstick. This mark is used later as a reference when inserting the tubing into the engine's oil sump through the dipstick pipe.

Step 2

From this mark add enough tubing to reach from the dipstick pipe to the vacuum pump (upright) and cut with a clean tubing cutter. Cutting the tubing with a pocketknife is not only difficult but often introduces contaminates into the sample.

Step 3

Insert the tubing into the head of the vacuum pump until it extends about 25mm (1") beyond the pump base and gently tighten the retaining nut.

Step 4

Remove the lid from the clean new sampling bottle and screw the bottle onto the pump. Protect the lid from contamination and minimize the length of time that the lid is off the bottle.

Step 5

Insert the tubing into the dipstick pipe to the mark made earlier. Don't let the tubing touch the bottom of the sump where it could pick up concentrated contaminates.

Step 6

Hold the pump upright and slowly pull the handle to draw the oil. Fill the bottle to the proper mark (usually about 3/4 full).

Step 7

Withdraw the tubing from the engine.

Step 8

Unscrew the bottle from the pump and screw on the lid. Make sure the outside of the bottle is clean and insert it into the mailing cylinder with the completed label. Most labs recommend that a sample of unused oil saved from the same batch as was drawn from the engine be also sent. This is used as a reference in the analysis. The "New Oil" bottle fits in the mailing cylinder with the drawn sample.

Step 9

Remove the tubing from the pump and properly discard. Never reuse the tubing.

Important Note: Never use the same vacuum pump for extracting coolant samples and oil samples. Glycol residue can cause a "false positive" in oil samples taken later.

ELECTRICAL

CHARGING TO SPEC

When you need more juice to supply your boat's DC loads, consider installing a battery charger. Here's how.

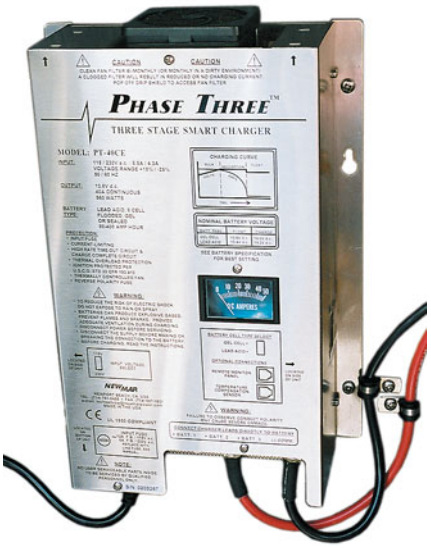
BY KEVIN MCGOLDRICK

It's almost a given these days that most vessels will have a plethora of electricity hungry goodies onboard from an anchor windless to extensive cabin lighting and electronic navigation devices. Advances in inverter design have allowed many to enjoy the convenience of AC power without the expense and installation problems of a genset.

All of these modern day wonders have one thing in common — the need for DC power and lots of it. Large battery banks and a means to recharge them are required to get the most from your onboard electrical system. Even vessels with modest power requirements need a safe and convenient means to recharge batteries. Aside from an engine-driven alternator, most boat owners add additional charging capacity in the form of an AC battery charger to meet this need.

This was exactly the task I had before me on my own vessel, a vintage 11m (36') Luhrs sedan cruiser. I had determined that a dual battery bank configuration would work best. Bank one is the house bank dedicated to all DC loads on the boat with the exception of starting the engines. It consists of two 6-volt Trojan, deep cycle, lead acid batteries wired in series with a capacity of 400 amp-hours. Bank two is the engine-starting bank, consisting of two Group 27, lead-acid batteries and is dedicated to starting the twin engines. Battery switches allow me to cross connect the banks to allow the engines to be started with the house bank and the starting bank to supply the house loads. A high-output alternator on the starboard engine recharges the house bank, while a stock alternator on the port engine charges the engine bank.

Before we begin let me provide a word of warning. Working with AC power is dangerous, especially on a boat with confined workspace that is surrounded by water. If you have any reservation about what you are doing, hire a competent marine electrician (ABYC-certified is best). Use this article to review your installation with your electrician before work starts to be sure your boat will stand up to a compliance survey when the time comes.

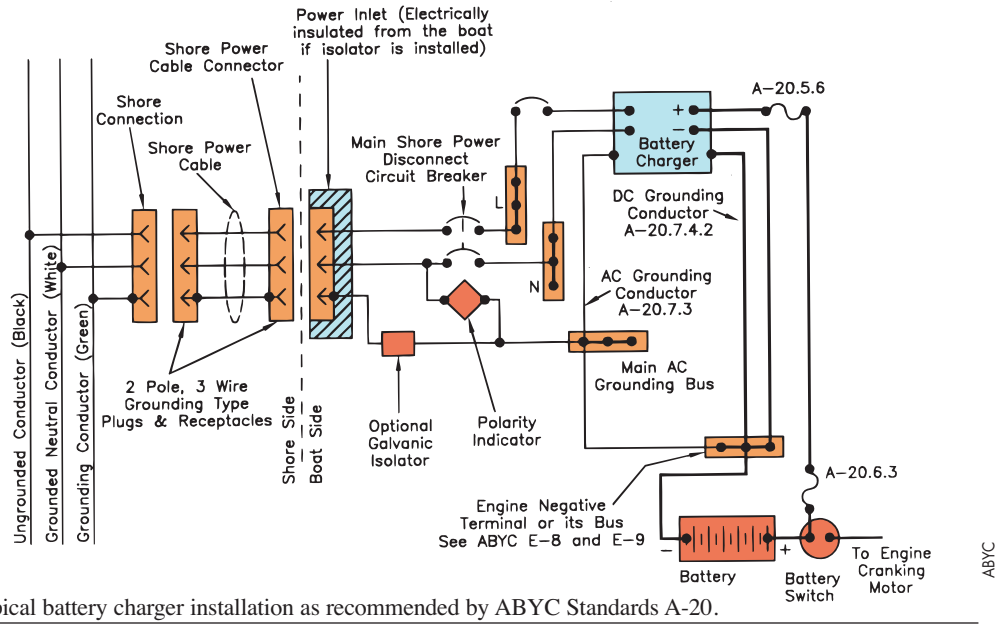


Battery charger during installation. Note that additional AC and DC case grounding wires are not installed yet.

Qualifying Factors

A battery charger is a unique piece of onboard electrical equipment because it's connected to both AC and DC electrical systems that subject it to a laundry list of electrical requirements under ABYC standards. Of major concern is where the unit is located. On gas-powered boats, locating a charger in an area that requires ignition protection, such as the fuel

FIGURE 1



Typical battery charger installation as recommended by ABYC Standards A-20.

tank or engine compartment, means that it must meet the ignition-protection requirements of SAE J1171 or UL1500. On all boats, the charger must be securely fastened to a bulkhead or other structure and the bottom of the charger must be positioned at least 61cm (24") from the normal accumulation of bilge water to protect it from splashing.

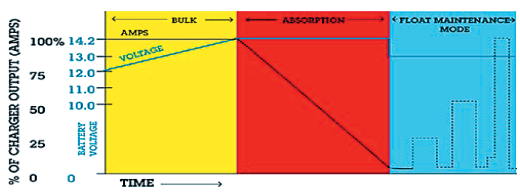
The charger's input current (AC) and output current (DC) must be protected with fuses. Another fuse is required at the point where the positive lead from the battery charger connects to the DC system (refer to **Figure 1**). If your charger uses a three-prong AC connection plug, as mine did, an additional grounding wire is required from the charger case to the AC grounding point. Similarly, an additional grounding cable is required from the charger case to the boat's common DC ground. Finally, the most overlooked aspect of a charger installation is to appropriately size the cable from the battery charger to the point where it connects with the DC system. To be conservative, I sized these cables to keep voltage drop to less than 3% at the batteries. [Ed: for ABYC voltage sizing charts and to determining conductor size in 24-volt and 32-volt systems refer to'DC Wiring Handbook" in 1998-#4 issue or MRT "DC Electrical Systems" CD-ROM.]

Which Charger?

I purchased a Newmar model PT40, 40-amp battery charger capable of charging up to three battery banks. It's a multi-stage or "smart" battery charger that recharges batteries in three stages resulting in a faster charge and maximum battery life (**Figure 3**). The bulk stage applies maximum current to the batteries when they can best tolerate it to bring them up to about 80% of a full charge. The absorption stage then maintains the higher charge voltage as the current gradually reduces until the battery plates are "saturated," meaning they are at approximately 100% or fully charged. Finally, the float stage takes over at a slightly lower voltage, applying only a small amount of current to the batteries to overcome their natural discharge rate and safely maintain them at 100% charge.

The PT40 is ignition protected and comes with input and output fuses built into the case. This charger is capable of charging battery banks up to 400 amp-hours

FIGURE 3



NEWMAR

Three-phase "smart" battery chargers results in a faster charge maximum battery life.

EASY-TO-MAKE BATTERY CABLES

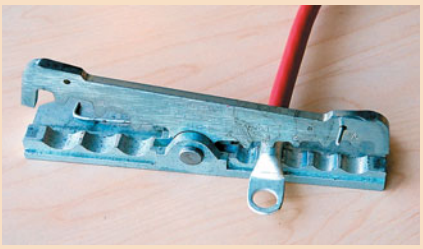
A custom installation of a battery charger usually requires that you make your own cables rather than purchasing pre-made cables in standard lengths. Installing lugs onto thick marine cable is not difficult if you have the proper tools.

BY KEVIN MCGOLDRICK

You'll need the following tools and materials to make one cable. Prices are approximate and in U.S. dollars.

- Cable cutter, to produce a smooth straight cut — $36
- Lug crimping tool — $29
- Butane torch or heat gun to shrink tubing — $22 to $70
- Hammer
- Sharp utility knife
- Cable
- Lugs sized for the cable and connecting stud
- Adhesive-lined, heat-shrink tubing

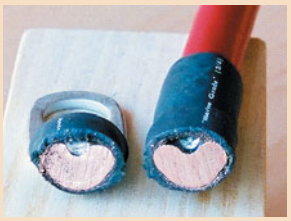
Determine the length of the cable by actually routing it and supporting it every 45.7cm (18"). Allow extra length at each connection point to create a drip loop so that water cannot travel the cable to the connection point. Make sure the ends of the cable are cut cleanly and evenly with the cable cutter. Remove the cable and cut approximately 16cm (5/8") of the vinyl cover off each end. Be careful not to nick the wire strands with the knife when removing the cover. It's best to cut the cover around the circumference of the cable, then make one cut from there to the cable end. This will allow you to peel the cover off rather than attempting to slide it off as is done with smaller wire. The exposed wire should bottom out in the lug with little bare wire visible.



Position the crimp tool in the middle of the lug barrel.

Little or no wire should be visible outside the lug.

A heat gun produces the best results when shrinking tubing. Note how the adhesive is squeezed out forming a watertight seal.



Example of what a good crimp looks like after the hammer blows. Note how the strands of the wire and the walls of the lug appear as solid copper.

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

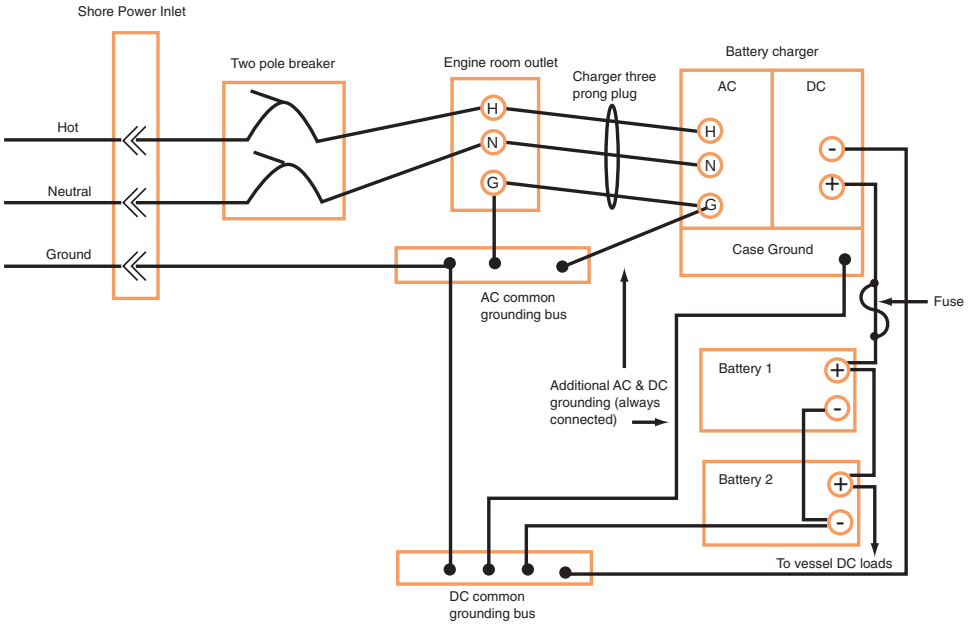
Next, cut a length of shrink tubing long enough to extend from the barrel of the lug to about an inch over the vinyl cover. Be sure to purchase adhesive-lined shrink tubing. During shrinking the adhesive melts to form a strong and watertight seal. Shrink the tubing using a heat gun, butane torch or similar device until a bead of adhesive is formed around the ends of the tubing. Be careful not to burn the wire cover. Use caution when using an open flame on a boat especially in compartments that may contain explosive gases. Ventilate the work area well before starting the flame and always have a fire extinguisher at hand for instant use. Allow the lug to cool completely before disturbing the wire. This gives the adhesive time to set and produce a strong bond. Reinstall the cable and stand back and admire your work. A cable created in this manner will likely last the life of the boat.

in capacity. On my boat, it safely charges my batteries and supplies all DC loads at the same time. A selector switch allows the user to charge AGM, gel cell or lead-acid type batteries. It's important that this switch be set to the correct battery type before charging begins. Charging AGM or gel cell batteries as if they are lead acid could dry out their electrolyte and cause premature failure or possibly cause the batteries to meltdown.

Wiring Issues

As this charger uses a three-prong plug for connection to the boat's AC system, I had to install an outlet in the engine compartment. I was able to daisy chain off an existing GFCI AC outlet in the cabin and installed a standard receptacle in a water-resistant Carlen outlet box (a brand name of plastic electrical boxes made for outdoor use). By installing the engine compartment outlet downstream of a GFCI outlet, it too is protected. With the exception of specialized hospital equipment, I'm not aware of ignition protected GFCI outlets for marine applications. Similarly on/off switches or breakers serving the engine compartment are more easily installed outside of the engine compartment in areas where ignition protection is not an issue.

ABYC Standards (A-20.7.3) state that the charger must remain connected via the AC grounding wire (the green wire) during servicing even when the hot and neutral legs have been disconnected. This is done to prevent electrical shock at the unit should AC power energize the charger via the DC grounding wire (presuming the AC and DC grounding systems are connected as per ABYC standards). Since this



GUY DRINKWALTER

Wiring schematic shows author's installation of 40 amp-hours charger.

charger uses a typical three-pronged plug, the grounding wire is disconnected when I unplug the unit for servicing. As a result, I had to add an additional grounding cable from the case of the charger to the grounding wire of the outlet, which always remains connected.

Wiring the DC side of the charger is similar to the AC side. The negative output cable connects to the DC common ground point; the positive output cable connects to the battery positive post. A DC-grounding cable connects the charger case to common ground. The positive cable from the charger to the battery is energized via the battery when the charger is off. Since this cable is not fuse protected at the power source (the battery in this case), ABYC Standards (A-20.6.3) require that a fuse be installed within 18cm (7") of the battery. Should a short occur when the charger is off, this fuse protects the cable.

All cables must be supported throughout their run at least every 45.7" (18"). It's good practice to create a drip loop where the cables attach to the batteries and charger so that water is less likely to travel the cable and cause a short.

Sizing for Voltage Drop

One of the most common mistakes is to install the wrong size cable from the battery charger to the batteries. Usually, this involves cable that is too small creating a large voltage drop at the batteries but I have also seen massive cables installed, which is just a big waste of money. In my installation, the charger output is 40 amps and is 2.4m (8') from the batteries making a total cable run of 4.8m (16'). Using this information and allowing for a 3% voltage drop at the batteries, the cable sizing chart calls for 6 AWG cable. [Complete tables to determine wire size requirements based on voltage drop are found in DIY 1998-#4 issue and the MRT "DC Electrical Systems" CD-ROM.]

About the author: Kevin McGoldrick is a freelance writer and a marine surveyor located in Long Island, New York. His website (www.mmsurveying.com) features information on getting the most out of your next survey.

POWER BOAT RIGGING

COMMON WINTERIZING MISTAKES

Winterizing a stern drive for cold-weather storage can result in costly repairs if the work is done too late in the season or done incorrectly. A marine surveyor provides a first-hand look at what can and does go wrong.

BY HARRY SWIECA

Gas prices and the yearly rituals of storing my boat are two things I dislike most about boating. If you are in the less fortunate group that boat where winter temps drop below freezing, the best you can do is make the winterizing job as painless as possible.

It's now fall. Your boat sits "on the hard." You've been too busy to winterize the engine but plan to do it some weekend soon. All it takes is a one night of below-freezing temperatures and you risk freeze damage to your engine. As a surveyor I'm often asked to inspect engines with freeze damage. (Many insurance companies don't cover freeze damage.) Even during a mild winter, like the winter of 2002 (in Illinios), I recorded the highest number of frozen engines on record. So what's everyone doing wrong?

Cooling Problems

Beyond the nuts, bolts and computers on the most sophisticated engines, your engine relies on water (raw or fresh) to remove heat. A freshwater or closed-cooled system incorporates a heat exchanger (**Figure 1**). This has two separate chambers, one holds the internal engine anti-freeze, the other has numerous cooling tubes through which is pumped cold freshwater. As freshwater passes through the tubes, heat is removed from the antifreeze mixture (**Figure 2**). Closed cooling systems are easy to winterize. Only the raw-water side of the exchanger and the raw-water pump are serviced. The main cooling chamber and engine block are not tampered with other than to check the coolant concentration or replace the coolant every few years.

Raw-water cooling is a different matter. This setup requires winterizing of the engine and all its parts in contact with water. All are protected in one of two ways: either by draining the entire system or by pumping antifreeze through the system. Rather than dwell on the aftermarket winterizing and pumping systems available, your service manual will recommend the best method for you to employ. If not, have it winterized as soon as possible by your dealer and watch how it's done. Pay close attention to the products they use.

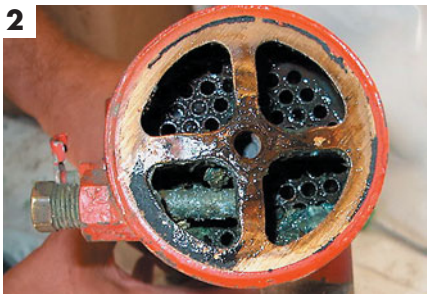
Myth about Freeze Plugs

During my fledgling car mechanic days, I was taught that all engines had freeze plugs and when temperatures drop the plugs pop out to keep the block from cracking. Only after becoming a marine mechanic did I learn the truth. Freeze plugs are in fact called welch plugs. They are round mushroom type caps that are pressed into the large holes on the sides of the cylinder block and cylinder heads (**Figure 3**). Marine engines use brass plugs to minimize rust. What's important is they do not pop when the engine freezes. Such plugs just seal the holes used to remove sand from the block after casting. They are not designed as freeze plugs. If a plug happens to pop out, it was only because it was not installed properly or the owner was just lucky.

1

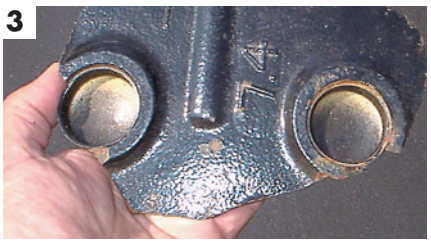
Typical heat exchanger located on the top of an engine usually towards the back. Cap is used to fill and maintain the system.

2



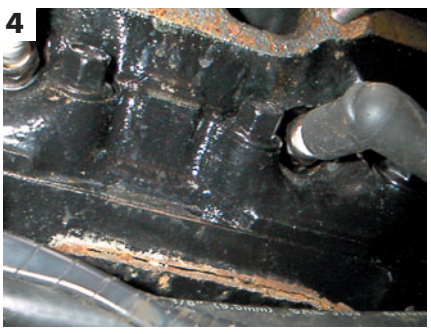
Inner metal tubes allow water to pass through, cooling the antifreeze. View also shows location of the internal sacrificial anode for corrosion protection of the system.

3



What was left of a 454 engine block after a quick cold snap. Note that both welch plugs are still in place.

4



Because of the design of the internal cooling chambers, freeze damage in cylinder blocks usually shows in the same areas.

5 Manifolds also crack in the same areas.

6 Drain cocks are brass pipe plugs, or brass or plastic inserts. All should be removed, rather than opened.

7 Using a small screwdriver as a probe will open a blockage of sand or silt and allow complete drainage.

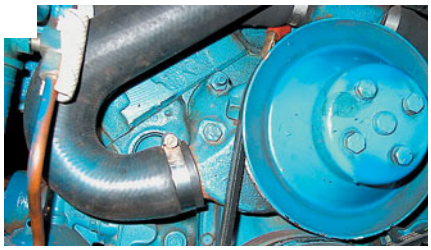
When water freezes in an engine, you'll typically find cracks in the block and manifolds and always in the same location. The block cracks just above the petcock or just below the cylinder head (**Figure 4**), the manifolds crack at the lowest point of the casting (**Figure 5**). Where it cracks is not important, if it's cracked, it's trash.

Proper Draining Procedures

Carefully follow the service manual when winterizing your engine and don't take shortcuts. On the sides of the cylinder block and on each side of the exhaust manifolds are metal or plastic petcock drains or brass pipe plugs (**Figure 6**).

While opening the valves does allow water from inside the engine to drain, it isn't enough to keep it from freezing. The inside of the block and manifolds fill with antifreeze residue, silt, sand or mud during normal operation. This sediment accumulates at the bottom of the block or base of the manifolds. Opening the petcock is not enough. The best way to insure complete drainage is to remove the petcock or plug completely, and probe the hole with a small screwdriver as it drains (**Figure 7**). When a solid stream of clear water or antifreeze is visible, allow it to drain completely. As a final step

probe each hole again to make sure it has drained completely. With the block and manifolds completely drained, look for other low areas such as the main circulating pump hoses (**Figure 8**). Oil and transmission coolers should also be drained. Check the hoses or drain plugs and probe for plugged holes (**Figure 9**). Remember to pull the plug on the raw-water pump or the housing will crack. If you follow the manual, this method is safe and inexpensive. After the water is drained, it's good practice to reconnect all hoses, but leave all plugs out and on top of the engine until spring just in case there is an air bubble in the system that needs longer to drain.



The main water circulation pump may have several low hoses that must be removed to completely drain the pump.

9

Your engine may have several engine oil coolers and or transmission oil coolers. Disconnect and drain the hoses is the most positive way to be sure the unit is protected.

Remove the filler cap on the heat exchanger and use an antifreeze tester to check the strength of the coolant. Change coolant as needed, depending on storage temperatures.

Antifreeze Facts

Using antifreeze to winterize and protect your closed-cooling or raw-water engine is the safest way if done correctly. It not only protects the internal parts of the block from freezing, it also provides rust protection. Again, follow your manual carefully if it recommends this method. The most common mistakes when using antifreeze are listed below.

Never use straight (undiluted) antifreeze. It doesn't provide better protection than the required 50/50 ratio of water-to-antifreeze mix. Antifreeze just doesn't work until it's mixed with water. [Ed: make sure the antifreeze that you use is the non-toxic plumbing type, known as propylene glycol, that will not pollute the environment.]

Always drain the engine block and manifolds prior to using your premixed antifreeze solution. Water in the engine further dilutes the solution and decreases protection.

Never run the engine on water and then add antifreeze through the engine's thermostat hose. The change in coolant temperature closes the thermostat not allowing enough of the solution to enter the cylinder block, which may still be filled with water.

Always run the engine for at least 15-minutes to circulate the antifreeze. Take the time to check the protection level of the closed system coolant before winterizing (**Figure 10**). [Ed: always use "operating" antifreeze or ethylene glycol in the heat exchanger. Bottles labeled "contains silicates" or "low-silicate formula" are clues that the product is an operating antifreeze.]

Never use a high-powered pump to force the antifreeze solution through the engine. This can feed back through the exhaust system and hydro-lock the engine causing serious damage.

Whatever way you choose to winterize your engine, either by draining, pumping antifreeze through the system or an aftermarket tank and gravity kit, read the instructions carefully and don't take shortcuts. Remember, don't wait, do it now!

About the author: Harry Swieca specializes in articles on engine maintenance and service and is a frequent contributor to DIY.

"HONEY, I SHRUNK THE COVER"

Shrink-wrapping a boat is an enigma to some people, even to those that have previously tackled this task. Considering the benefits and cost savings, it makes sense to master the art of shrink-wrapping. With the proper tools and these logical steps, it's surprising easy.

STORY AND PHOTOS BY JAN MUNDY

Materials

Installation kit
Hardware kit
End caps
Vents
Access door (optional)
Ladder
9kg (20lb) propane tank,
Fire extinguisher
Gloves (fire-proof)
2x4 studs
Saw
Stapler
Wrench
Tape measure

Walk about the boatyards and you see all types of boat covers. Frames made of 2x4s, conduit, ABS piping, often draped with cheap tarps in various stages of decline. A scarce few boats are fitted with custom-made covers. I've engineered three covers based on yard designs for our 6.7m (22') powerboat, all with mediocre results.

Year one, I didn't want to pay the $20 per foot (per 30.4cm) quoted to shrink-wrap the boat, so I hung a tarp over wood supports. Year two, a rope gridwork supported the boat's trailering cover. Year three consisted of an elaborate support structure made of ABS piping that was covered with the worn, patched boat cover and numerous tarps. Three strikes equal an out. A do-it-yourself shrink-wrapped cover appeared to be the best option and, from what I'd observed, it didn't seem beyond my capability.

I'd heard lots of "wharf chat" about other boater's experiences with taking on the task but rather than rely on the war stories, I decided to check it out for myself.

Paul Murray, store manager of Boat/U.S. in Mt. Clemens, Michigan, agreed to organize a shrink-wrapping demonstration with Mike Stenberg of Dr. Shrink (www.dr-shrink.com). Mike has "wrapped" hundreds of boats while instructing boatbuilders and during demonstrations at trade shows. We met Paul and Mike early at the store on a calm, windless day. McMachen Marine (www.mcmachenmarine.com), a nearby boat dealer supplied the demo boat, a 6.7 (22') Four Winns bowrider. Before we show you the steps to wrapping like a pro, let's review the components of the job.

Not all Film is Equal

Shrinkwrap (also referred to as "film") is available in various widths, lengths and thickness and comes in blue, white or clear.

Blue film performs best in northern climates as it absorbs heat, which allows snow to slide off. White transmits natural light, an advantage for brokerage boats or working on the boat in warm climates as it doesn't shed snow. The clear film is also best used in warm climates but is the most difficult to handle as it doesn't show the telltale distortion that precedes a burn through. Amateur "shrinkers" should stick with blue or white.

Shrinkwrap, like most plastic sheeting, is rated in mls. The higher the ml, the thicker the material. A 6ml or 7ml are strong enough to withstand hail, rain or snow and are recommended for boat storage covers. Thinner films, typically used by boat manufacturers when transporting boats, are tricky to use as they puncture easily during the shrinking process. The thickest film is 12ml, a specialized flame-retardant material for commercial use.

Some films are better than others; purchase buy the best grade you can afford. Inexpensive films tend to burn through easily, causing holes and requiring mending. It's shortsighted to cheap out on the price when the difference between barely adequate and adequate quality may be relatively insignificant on a 12m (40') boat. Quality films have high opacity (not transparent) and

are UV protected. Dr. Shrink films, for example, are warrantied against UV breakdown for 12 months.

Tools for Success

Two tools are key to a successful shrink-wrapped cover: a tensioning tool to tighten the perimeter band and a propane-fired heat gun to shrink the film.

The perimeter band is a very tight piece of strapping that runs horizontally below the boat's rubrail (sheer) to secure the entire cover. This band must be extremely tight so it doesn't move up and down and chafe the hull. A heavy snow load can also weigh down the cover and lift the band, causing the cover to collapse and possibly damaging windshields, railings or other hardware. On smaller boats, you may be able to hand tighten the band. On larger boats, it's impossible to get the band tight enough without using a tensioning tool.

Shrinking film is not a job for the handheld, propane-fired paint stripper sold at hardware stores. Too much heat and an uncontrolled flame can result in a cover that resembles a pincushion. The right tools are worth the investment, particularly if shrink-wrapping is an annual event. What you spend on the right equipment, you'll save on the cost of the film destroyed by the wrong torch. If shrink wrapping is an annual event in your area, consider splitting the costs with a boating buddy or suggest that your club purchase the tools.

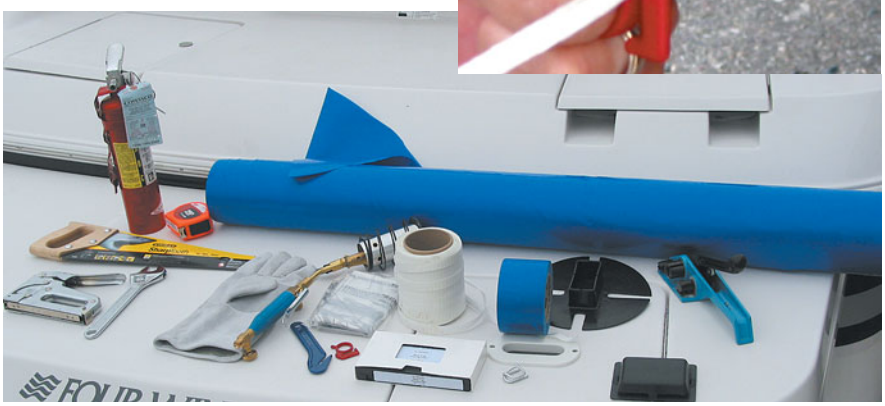
Dr. Shrink has designed other specialty tools that expedite cutting. A film cutter with replaceable blades and a protective end won't damage the gelcoat, graphics, etc. when cutting. A ring cutter is a handy device to cut strapping and it fits tidily on the thumb.

Installation Components

A web of straps and uprights make up the support frame. Woven polyester strapping, preferably 19mm (3/4") wide, joined together with buckles, comprises the frame. Look for heavy-duty strapping that is tightly woven and doesn't break easily when you give it the tug test.

Adhesive-backed tapes, used to secure folds in the film and access doors and repair holes, come in four widths and are color-matched to the film. Preservation tape has UV inhibitors and it's ideal for applying directly to the hull, as it doesn't transfer a messy adhesive residue. Shrink-wrap tape is less expensive and commonly used on the film but it tends to break down, much like duct tape does.

Reusable, padded end caps that mount over 2x4 posts to prevent posts from poking through the cover are now available. In the past, installers would bundle a blob of shrinkwrap and staple it to the post but this padding was inconsistent with sometimes damaging results. Other options include reusable access doors in three sizes and self-adhesive vents, an important add-on to reduce condensation buildup and subsequent mildew growth. In northern climates, vents are placed as low as possible. On a powerboat they install close to the gunwales, on a sailboat, close to the deck. In warmer climates, vents mount as high as possible to eliminate heat build-up. Our demo boat needed four vents; a 15m (50') boat would require eight vents or more. To reuse vents, stick on with double-sided tape. For maximum airflow, consider mounting on the cover a solar-powered vent using double-sided tape.



(above) The key to success is in having the right tools and knowing how to use them correctly. (top right) Dr. Shrink's handy ring cutter.

Getting Started

Dr. Shrink installation and hardware kits and film are sold at Boat/US and West Marine stores. Three sizes of installation kits, containing strapping, self-locking buckles, tape, vents and a recycling bag, fit boats up to 11.5m (38'). Custom sizes are available by special order.

While assembly of the components is easy, operating the heat tool requires some skill to ensure a durable, tightly fitted cover. Purchase extra film and, before covering your boat, Mike urges that you practice wrapping and shrinking a box or trash pail, the barbecue, patio furniture, garden tractor, whatever. To operate the heat gun, open the main gas inlet on the tank, turn on the pilot light on the gun and ignite it. The trigger adjusts the heat from 3,000 to a blazing 300,000 BTUs. For better heat control, Mike suggests placing a finger or two under the trigger to act as a cushion to prevent the flame-thrower effect that melts the film. Watch the training video; reread the instructions and practice until you are comfortable

with the gun.

Shrinking film is similar to rolling paint on a wall. Start at the bottom and just keep "rolling" it out, moving upwards and side to side. The goal is to apply just enough heat to remove as many wrinkles as possible. Always have a fire extinguisher handy in case you ignite the plastic, though most times it tends to smolder. There are also other combustibles in the area that can go up in flames. It's a good idea to wear a long-sleeve shirt to avoid singing the hair on your arms.

Proper throttle control.

Design of the frame is critical to prevent accumulation of rain, snow or ice on the storage cover A typical design has one fore-and-aft strap, three or more tied from side to side, three or more vertical posts, a perimeter band and tie-downs (belly bands) for the band located on each side behind the windshield and towards the stern. When complete, the objective is to have a frame that slopes front to back and side to side with a 5-pole pitch, like on a house roof. Smaller boats are often more difficult than large ones because of the shape and deck obstructions, such as fishing boats with rod holders. Cabin cruisers with high aft decks or flybridge require a more complex setup. Sailboats require three fore-and-aft straps, one on the centerline and one on each side, half the distance to the deck edge. Using only one center strap or the boom presents too much unsupported material, resulting in low spots and a loose cover. Sailboats and boats with more rounded hull shape also require bellybands at the keel and then every 1.8m (6') along the bottom.

The support frame, posts and end caps, vents and access doors are all reusable. When it comes time to cover your boat again, all you need to purchase is the film, a roll of tape and some webbing to replace the perimeter band. To determine the width of film needed, measure the distance from the maximum height on deck at the centerline to about 45.7cm to 63.5cm (18" to 25") down from the rubrail or just below any graphics plus 15cm (6"), at the maximum beam (width) and multiply by two. On our demo boat, the band rested 2.3m (7-1/2') from the centerline. This allows the film to tuck under the band. Length is measured along the centerline from bow to stern at the highest point, adding the extra amount below the rubrail.

Helpful Hints

"Anyone can shrink-wrap a boat cover if they follow a series of logical steps," says Mike. Skimping on the materials, using the improper tools or rushing through the job causes most shrink-wrapping problems experienced by DIYers. "Using 2x2s rather than 2x4s, substituting polyethylene rope, which stretches 10% or more, for the nylon webbing that stretches only 2.5% just before it breaks at 499kg (1100lb) of tension," explains Mike. "If you don't take the time to build a support frame or make a straight and tight bottom band, the cover collapses. Another problem is too much heat, which causes the shrinkwrap to separate or creates pinholes."

Plan your frame design on paper before installing. When you're ready to shrink-wrap your boat, wait for a windless day and invite some buddies to help. Strive to construct a cover that is as tight and wrinkle-free as possible so rain, hail and snow just bounces off.

Remove convertible top and bow tonneau cover. Never leave on any covers as they chafe. Moreover, they trap moisture under the shrinkwrap layer.

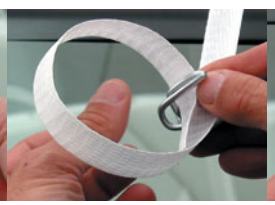
Make a yoke at the bow that spans the width plus about 30cm (12"). Tie the ends to side cleats. Where there are no side cleats, tie a big loop to the center bow cleat or to the bow eye on the hull. Remove the twist in the strapping so it lies flat. No fancy knots here; just tie whatever holds. Make a yoke at the stern, again adding about 30cm (12") to the width. String a strap from end to end, tying it to the middle (highest point) of both the bow and stern yoke.

Measure for wooden vertical supports. This boat has three: one close behind the windshield to take the pressure off the windshield; one in the bow compartment; and one just forward of the sundeck. Measure distance from floor to centerline strap behind the windshield, extending the strap to maximum height. Do the same at the the bow and stern.

Cut 2x4s to size and push on padded end caps. Cut two crosspieces of scrap having a length of the distance from the centerline strap to a tie off point on the side plus 30.4cm (12"). If there are no springline cleats, tie to the rail or trailer (if equipped) or run a continuous strap underneath the hull. Line up the post with the crosspieces. Lay centerline strap in slots in the end cap and securely staple to cap.

Cut posts for bow and stern supports and attach crosspieces.

Join crosspieces with a buckle. Remove twists then thread strapping through the buckle, around and back through and pull as tight as feasible. Cut off ends for neatness. Staple crosspiece to the cap.



Buckles absorb heat sooner than the shrinkwrap and can burn a hole through the film. To prevent this, tape buckles located near the centerline of the support frame.

Tape the vent hole on the gas tank vent fitting to eliminate any chance of escaping volatile vapors encountering flames from the heat gun. If you cannot locate the vent, call your dealer or the manufacturer. Put a strip of tape on the hull bottom directly below the vent as a marker so you can easily locate the gas vent after the boat is wrapped.

Attach ties for the perimeter band. Measure from the rubrail at the highest point at the deck edge (the windshield on this boat) to 15cm (6") below any graphics.

Cut two pieces of strapping to length and secure each one to cleats on both sides. Remove twists in these ties and then make a small loop on the end. Attach ties to each side at the bow and transom. Tie loops in the ends, also. When sighted, all ties should form a near horizontal line around the boat. The straighter the band, the easier it is to install the film. Larger boats require an extra two or three loops per side, as do sailboats because of their pear shape.

Beginning at the stern, thread strapping through the loops, laying it as flat as possible, though a few twists won't cause problems. Check alignment and adjust loop heights on ties as needed to form a relatively straight line.

Lay the perimeter band above the lower unit so the cover protects it. Leave extra length, cut the end, install a buckle and hand tighten. Check that the band isn't wrapped around the trailer, jack stands or cradle. Tuck a couple pieces of scrap film under the band at the corners to allow some slack in the band.

Using the tensioning tool, tighten the band until you think it's tight enough, then give it a few more turns on the tool. It's tight when you can pull out the band just 25mm (1") at amidships; absolutely no slack in the band at the bow.

Beginning at the stern, drag the film over the support frame until it extends at least 15cm (6") below the perimeter band at the bow. Best to unroll in on a stick or somehow support the film off the ground to keep it clean for it attracts debris through static electricity. Unfold the film and tuck it under the band in a few places to temporarily anchor it.

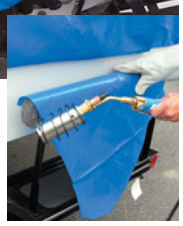
Check that there is enough overlap on both sides and then, using the film cutter, cut away the excess 15cm (6") or so below the band.

Pick a starting point (in this case the windshield) and, working towards the stern, pull out the band and tuck the film overhang underneath. Then go back to your starting point and work forward, tucking the film under the band.

Form pleats in the film where the hull width begins to decrease (the windshield on our demo boat) and tuck under the band. Do the same on the other side. Pleats are required wherever there's excess film, such as windshields, transom corners, the bow, flybridge, arch, etc.

To shape the bow, grab the film about 15cm (6") below the rubrail and pull it straight out. Cut if off about 15cm (6") beyond the rubrail (deck edge) at an angle that follows the shape of the hull and tuck it under the band.

Depending on the shape of the stern, pull the film back and cut it off 6' below the band. Tuck in the film at the corners, forming small pleats.



Cover any exposed carpet on the trailer with pieces of shrinkwrap to protect from igniting.

Don't Trash Your Wrap

When your boat is ready to come out of storage, cut off the cover just above the perimeter band. Use the film cutter to prevent damaging the hull finish. Gather up the cover and place in the supplied recycling bag. Call UPS and it's shipped prepaid to Dr. Shrink. Unfortunately, this service is only available in the U.S.

Beginning at the transom (if you're right-handed start on the starboard side; lefthanders start on port.), heat weld the perimeter band to the shrinkwrap. Using the heat gun, just lightly touch the film to form a 7.6cm- (3"-) high weld. About a second is

all it takes to weld the layers, then follow by lightly tapping the welded area with a gloved hand to flatten the film. Go slowly! Be sure a fire extinguisher is handy. Continue welding and tapping, slowing moving around the bow and down the other side, and around the transom. When completed, if the band was tightened sufficiently, you cannot pull it away from the hull.

Securely fasten the perimeter band to the trailer or cradle or attach bellybands where a strap runs underneath the hull to connect the band on each side. (Never tie to jack stands. Any wind that gets under the cover can pull out a stand.) Our demo boat required two ties per side: one located behind the windshield, the other towards the stern. Make a small horizontal cut above the perimeter band. Thread a strap through from the back, remove any twist and snug it down until the band is in its original location. Don't overtension as you can cause pressure points in the cover.

Ready to shrink the cover. Sectionalize the cover, picking a starting and stopping point. A good reference point is the straps. Shrink from the perimeter band or from lifelines and rails if equipped, towards the windshield or the boat's centerline. This pulls all the flab out of the top. Always start at the bottom, never the top. As heat rises and builds up in the apex, it assists in pulling out the wrinkles.

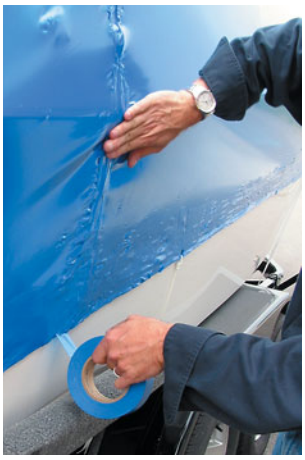
"Herding the wrinkles." When the film starts to shrink, wrinkles form around the edge. Using the heat gun herd the wrinkles towards the centerline.

Our demo boat was easy as the top was within reach. Larger boats require using a ladder, which can cause problems. Should a section cool between ladder moves, it may harbor wrinkles, which may affect cover tightness. If you see wrinkles, apply a little more heat, have some patience and go slowly.

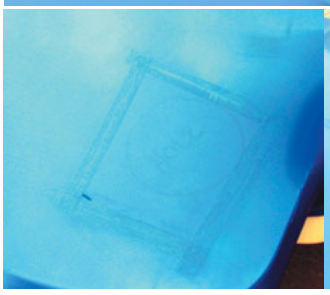
Obviously, there are wrinkles around any curves and pleats, but this won't affect the cover's tightness or durability.

As the cover cools and heat dissipates, the wrinkles disappear, resulting in a smooth, tight cover. This is proof of a quality film.

Tape all pleats so they lay flat.



No cover is complete without a hole or two. We didn't have any, so we fudged one to show you the repair process. For small pinholes, cut a piece of tape, round the ends, place over the hole and press towards the edges to remove all air bubbles. For a "man" sized hole (refer to photos, top left, clockwise), cut a piece of scrap film that is about 5cm (2") larger than the hole. Lay over the hole and tape all four sides to the cover. If the cover is cold or wet the tape won't bond. To tack it down, use the heat gun to warm the adhesive on the tape. Don't apply too much heat or the tape turns into a gumball.



To install a self-adhesive, two-part vent, remove the backing paper from the base and stick it to the cover. Cut out the center portion, run fingers around the inside to firmly press the vent to the cover, then snap on the cover. Our demo boat used four vents: two on the bow and two near the stern, all mounted just above the gunwales.

Lay the access door flat on the cover and tape around the perimeter, smoothing the edges to remove all air bubbles trapped under the tape. If cold or damp, lightly touch the tape with the heat gun to activate the adhesive. Unzip the door (it has a two-way zipper) and cut out the inside, being careful not to cut through any strapping.

Locate the gas tank vent fitting and cut a small hole in the film here using hook on the film cutter. Remove the tape placed over the vent hole in the initial preparations, and then either tape over the small hole or mount a vent. Remove reminder tape on the hull.

TOTAL TIME = 2 hours 40 minutes

DIY BILL

Below is the cost to shrink-wrap our demo boat. Note that tools and some components are a one-time purchase and are reusable for subsequent covers. Prices are in U.S. dollars.

Hardware Kit DS-789 propane-fired heat gun with 7.6m (25') hose, adjustable regulator, pair of long cuff leather safety gloves, safety glasses, written application instructions and training movie on DVD.	$315.00
Installation Kit 1 roll 19mm x 91m (3/4" x 300') woven cord strapping, 10 19mm (3/4") buckles, 1 roll 5cm x 10.6m (2" x 35') shrink-wrap tape, 4 self-adhesive vents, 1 Dr. Shrink Rebag kit	$18.50
Access Door, reusable, 76cmW x 91cmL (30"W x 36'L) Other available sizes: 76cmW x 122cmL (30"W x 48"L), 91cm x 182cm (36"W x 72"L)	$19.95
End Caps 3, 23cm (9") diameter padded	$3.00
Posts 3, 2x4sx8'	$3.00
Shrinkwrap 5.1m x 9.4m (17' x 31') blue 6ml shrinkwrap Fits boats up to 7.3m (24')	$37.50
Total shrink-wrapping cost for demo boat (first year)	$396.95
Total shrink-wrapping cost for subsequent years (estimated)	$47.50

BUILD A CUSTOM CANOPY

A step-by-step guide to building a weather-tested cover that protects your boat from the elements and lets you work onboard sheltered in relative comfort.

STORY AND PHOTOS BY SUSAN CANFIELD
ILLUSTRATIONS BY GUY DRINKWALTER

Tools

- *Tape measure, 3m & 15m (10' & 50')*
- *Chalk line*
- *Colored chalk sticks*
- *Permanent markers*
- *Tubing bender, 3/4"*
- *Tubing cutter*
- *Drill, 12V 9mm (3/8") cordless*
- *Drill bit, 5.5m (7/32")*
- *Tap, 1/4"-28*
- *Screwdriver, phillips*
- *Socket wrench with 12mm (1/2") deep socket*
- *Stepladder*
- *Torpedo level*
- *String*
- *Knife*
- *Lead sinker*

(top) When it comes to a weatherproof working cover, it doesn't get much better than this. (bottom) White shrink-wrap was my cover of choice. It lets in plenty of light, provides shade from the hot summer sun, and sloughs off rain and snow. If I want to work at night, I can clip a couple of lights to the cover frame and the white shrinkwrap becomes a big lampshade. Note the wood blocks positioned under each vertical support.

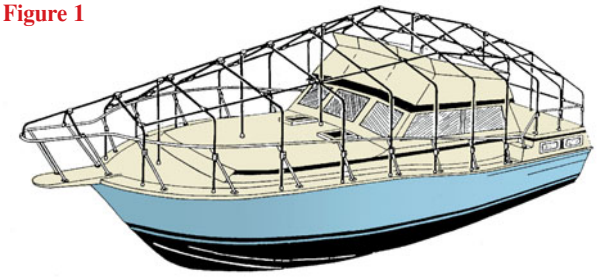
If you live in an area where boating is a seasonal activity, covering your boat for the winter should be a no-brainer. A good cover pays for itself by preventing damage that occurs when a boat is left uncovered: gelcoat weathering and cracks, deck leaks and delamination, water-stained interiors, corrosion, mildew and rot. Most often, a winter cover is tightly fitted to the boat to keep the cover material from flogging itself to death in high winds. Often, you can't work on the topsides when the cover is fitted or move around on deck freely. Ventilation under a winter cover is usually limited at best.

Before starting phase two of my 22-year-old boat's ongoing overhaul, I built a working cover frame that allows unfettered access and excellent ventilation. It's shrinkwrapped extended canopy is tall enough that I can work anywhere on deck (reinstalling deck fittings and varnishing) and wide enough for access to the caprails (varnishing) and topsides (paint touch-up).

Having used the Kover Klamp (KK) framing system to support my boat's winter cover for many years, I knew I could build an extended-canopy frame using the same components. The greater challenge was to make the new frame freestanding, since I'd removed my boat's lifeline stanchions during overhaul. In the end, I accomplished both objectives. The extended canopy, in particular, is a great improvement over the standard boat cover frame and one well worth the additional complexity and expense involved. A freestanding frame, on the other hand, is rarely needed and adds considerable expense. It also requires alternative anchor points (in lieu of lifeline and/or handrail stanchions) so that the frame can be secured to the deck.

The standard KK boat cover frame (**Figure 1**) uses 19mm (3/4") electrical conduit (EMT) held in place with patented steel clamps (**Figure 2**). It's like Tinker Toys on steroids! While a KK frame costs more than one made of wood, it's far easier to work with, stores compactly and is

Figure 1



The standard Kover Klamp cover frame is anchored to a boat's life-line stanchions or deck railings.

Figure 2

Kover Klamps are designed to hold 19mm (3/4") ID electrical conduit (EMT) at any desired angle. A rubber tab between the clamp's two metal plates grips the conduit, a single bolt locks everything in place. Assembly is easy with a socket wrench.

certainly economical in the long run.

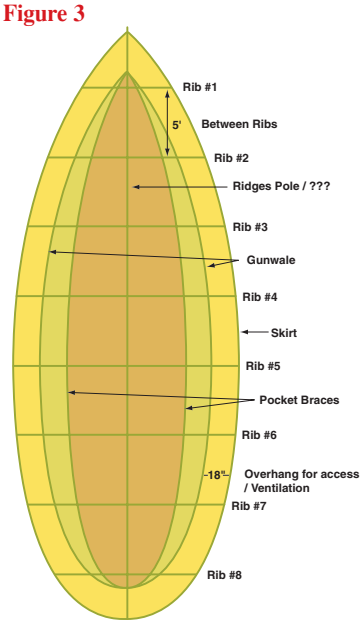
If a standard frame meets your needs, you can simply refer to the KK website (www.koverklampframes.com), their printed materials and the instructional video included with their boat cover kits. If you're interested in building an extended-canopy frame, that may or may not be free-standing, a "how-to" guide is provided below.

Design

Weather must be the first consideration when developing a design and choosing materials for a boat cover. On Chesapeake Bay, where I live (and boat), winds typically range from calm to 15 knots. Violent thunderstorms can produce wind gusts of up to about 50 knots. Fortunately, hurricanes are infrequent. One winter, we may get 1.8m (6') of snow, the next virtually none. I chose a frame design (60° slope) and cover material (shrinkwrap) that readily shed snow and ice. In the event winds over 50 knots are forecast, I'm prepared to remove the cover.

Determine the length of your frame's

Figure 3



The author's 12m (40') extended-canopy frame (overhead view). Rib #1 is aft of the bow, rib #8 is 30cm (12") forward of the stern. Pocket braces keep the ribs parallel with each other and prevent the cover material from pocketing between ribs. The pocket braces extend from the first to last rib, halfway between the ridgepole and the bend of the rib legs.

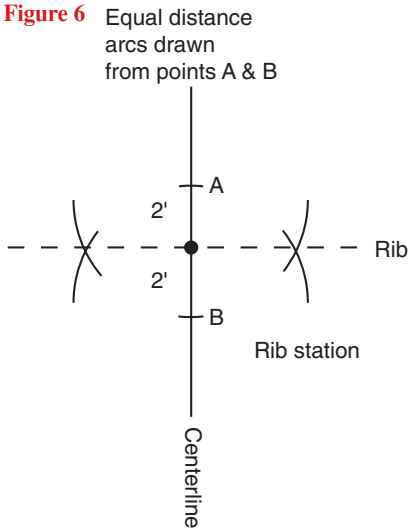
Figure 4
Rib spacing and spans. The author's canopy frame is 12m (40') long; her boat's length on deck is 11.2m (37') (CL=Centerline).

Station#	Distance From Bow	Distance CL-Gunwale	Plus 18" Overhang
1	1'	25"	43"
2	6'	44"	62"
3	11'	61"	79"
4	16'	68"	86"
5	21'	68"	86"
6	26'	66"	84"
7	31'	55"	73"
8	36'	32"	50"

extended canopy. Verify your boat's overall length on deck (LOD), typically listed in the manufacturer's specifications, by taking your own measurements. Then add the desired overhang at bow and stern. Example: since my boat's LOD is 11.2m (37'), and I wanted its working cover to extend 45cm (18") beyond the gunwales, my canopy frame needed to be 12m (40') long.

Determine the number of ribs, their spacing and spans. How many ribs will be needed to support the canopy? If the canopy's vertical supports will be anchored to the deck

Figure 6



To accurately draw each rib perpendicular to the centerline, first draw short intersecting arcs using a string and chalk that are equidistant from two points along the centerline. These points must be equidistant from and on opposite sides of each rib station. Finally, draw the perpendicular line (rib) so that it extends through the rib station and intersecting arcs.

stanchions or railings, rib spacing must correspond. If adjacent stanchions are more than 1.5m (5') apart, however, add a floating rib in the middle. If the frame must support heavy snow and/or ice, space the ribs at shorter intervals. My frame, for example, is freestanding with ribs 1.5m (5') apart (**Figure 3**). Measure the distance between gunwales at each rib station. Divide by two to obtain the centerline-to-gunwale distance, and then add the desired amount of overhang. Record your calculations as shown in **Figure 4**.

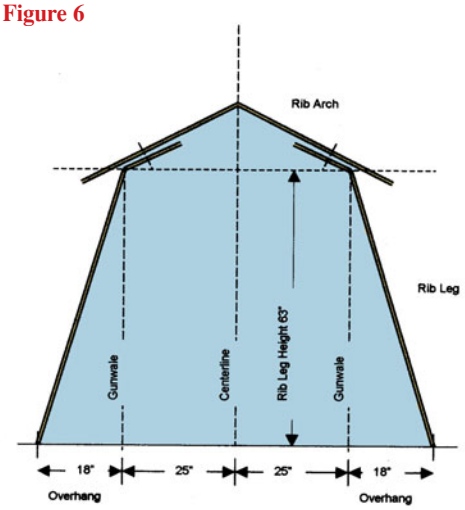
Determine the desired rib leg height. Don't make your cover frame any taller than it needs to be as height creates windage, a disadvantage when the winds blow. Since I'm 160cm (63") tall, a rib leg height of 1.6m (63") makes it easy for me to move about on deck.

Construction

An extended-canopy frame is far easier to build on a level surface than on deck. Lacking a suitable paved area near my boat, I used a neighborhood tennis court during the off-season. But I then had to disassemble, move and reassemble the frame at my boat. Fortunately, the disassembled frame and all its components could be transported by car in a single trip.

Draw the canopy frame in overhead view. Using a chalk line (florescent colors work best), mark the centerline of your canopy frame on a level paved surface. With a tape measure and colored chalk, mark each rib station along the centerline. Next, draw each rib perpendicular to the centerline (**Figure 5**). Put an "X" at the appropriate centerline-to-gunwale plus overhang distance in both (port and starboard) directions along each rib. Use the chalk line to mark the canopy's skirt. Connect the X's at the end of each rib moving from bow to stern, then back along the opposite

Figure 6



Rib Construction: Place two rib legs on your chalked pattern. Align the rib arch with its center on the pattern's centerline with the rib legs. Mark and cut the conduit where the arch and legs overlap (about 20cm/8" above the bend). The measurements given here are for rib #1 in the author's frame.

side.

Assemble the longitudinal elements. Connect lengths of EMT with KK couplings (standard EMT couplings lack the strength needed for frame construction) to form the ridgepole. With the tubing fully seated in the coupling, drill and tap the conduit to accept the setscrews (6mm x 1.0mm). If you don't have a metric bit and tap, you can use a 7/32" bit and a 1/4"-28 tap. Ensure that all the setscrews face in the same direction so they can be oriented away from the cover.

If you're building a freestanding structure, you'll need to separate the assembled canopy frame into self-supporting modules for installation on deck. I separated my boat's canopy frame into five self-supporting sections: three-legged bow and stern sections, and three four-legged rib pairs (2-3, 4-5, 6-7). Ensure that your ridgepole's couplings fall where needed. If your frame's vertical supports will clamp to deck stanchions and/or railings, coupling location is not an issue.

With the ridgepole (and couplings as appropriate) correctly positioned on your pattern, use a broad

tipped 12mm (1/2") permanent marker to mark each rib station, circling the EMT. Assemble both pocket braces in the same fashion, however, you needn't mark the rib stations. Don't worry about cutting the ridgepole and pocket braces to their proper length; just set them aside for now.

Next, assemble the canopy's skirt. Bend and connect lengths of EMT to conform to your pattern. Remember to position the couplings for modular installation if you're building a freestanding frame. Drill and tap the tubing at couplings. Finally, with the assembled skirt lying on your pattern, use the broad-tipped marker to indicate where each rib leg should land.

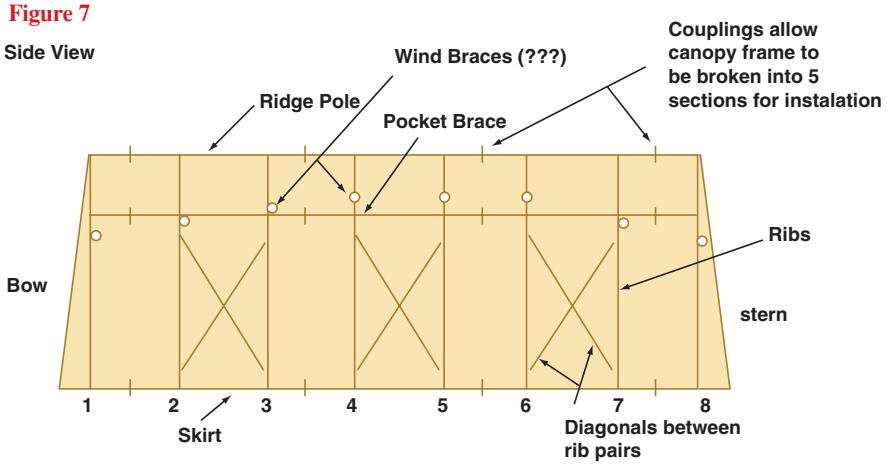
Draw the rib patterns. In a clear area, use your chalk line to make a straight line longer than your canopy's longest rib span including overhangs. This is the baseline used for rib construction. Starting in the center of the baseline and working in both directions, mark the centerline-to-gunwale (without overhang) distance for rib #1. Next, draw lines perpendicular to the baseline at the center point and gunwale distances. Then mark your desired rib leg height above each gunwale, and desired overhangs along the baseline (**Figure 6**).

Assemble the ribs. Using a separate length of EMT for each rib arch, mark the center and bend 60°. Using a separate length of EMT for each rib leg, mark the desired height and bend as needed to fit your pattern (approximately 50°). Placed a pair of rib legs on your chalked pattern as shown in **Figure 6**. Then align a rib arch with its center mark on the pattern's centerline with the rib legs. Mark and cut the EMT where the rib arch and rib legs overlap (about 20cm/8" above the bend).

Join the rib segments; drill and tap for the setscrews. Again, ensure that the screw heads face inward so they won't poke holes in the cover. Repeat this process for each rib. Use a permanent marker to draw lines around each rib halfway between its center and the bend in each leg. These are reference marks for the pocket braces that will be fit later.

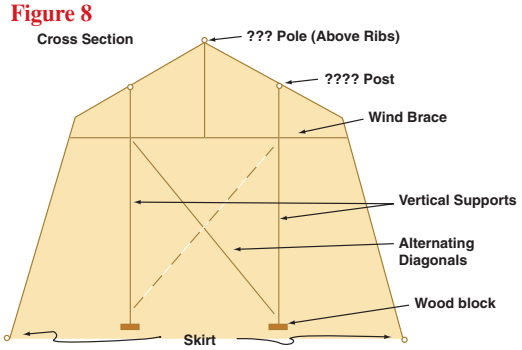
(above) Frame assembly on deck requires a minimum of tools (from left): torpedo level, tubing cutter, tap wrench, Phillips screwdriver and socket wrench with 12mm (1/2") deep socket. A canvas waist apron provides pockets for carrying clamps, slide locks, hand tools and a marking pen.(right) The Kover Klamp framing system includes (clockwise from left): protection pads, plastic plugs, rubber tips, slide locks, couplings and patented clamps.

Figure 7



(above) The author's extended-canopy frame breaks into five freestanding sections, as shown below, for modular installation on deck.(below) Extended-canopy frame with free-standing supports (cross section view). Frame and canopy tie-downs are not shown.

Figure 8



If you're building alongside your boat, it's time to run a tie-down line through each rib. Otherwise, wait until you reassemble the frame for installation on your boat. A one-ounce lead sinker on a string can be used to fish the line through each rib. Before tying a bowline in both ends of each tie-down (where they exit the conduit), slip a length of clear plastic tubing over the line for chafe protection. Make sure your knots are large enough to prevent the tie-down loops from being pulled back through the EMT. I used 4.7mm (3/16") line that has a breaking strength of 544kg (1,200lb) and added a rolling hitch above each bowline.

Assembly

Assemble the canopy frame. Position rib #1; clamp the end of each leg inside the skirt. Use temporary diagonals to keep the rib vertical. Try to fit the clamps in a consistent way. Repeat the process for the next rib. Once two ribs are standing, fit the appropriate ridgepole segment above the ribs; ensure that the ribs are plumb. As you assemble the canopy frame, cut and fit diagonal supports as appropriate (**Figure 7**). If all four diagonal braces for a rib pair are cut to the same length, they'll be interchangeable on reassembly.

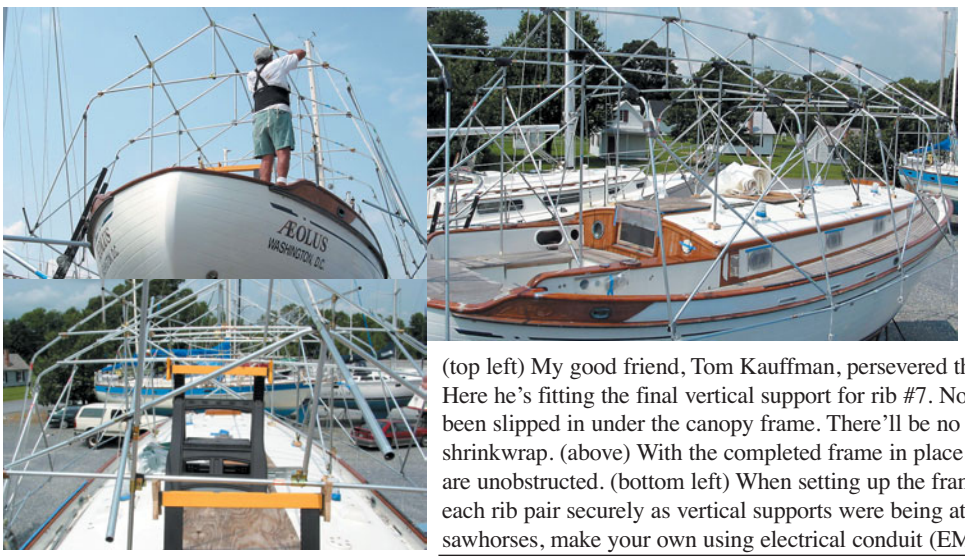
After clamping the ribs, ridgepole and diagonal supports in place, clamp the pocket braces under the ribs. Bend and fit the bow and stern legs and attach them to the ridgepole. Drill and tap for the setscrews. Next, install a wind brace at each rib to prevent the canopy from deforming in high winds. Use a slide lock inside each clamp to prevent it from slipping inward. If your frame is to be freestanding, you'll also need to fit a compression post on the centerline between each rib and its wind brace. A post is not needed if the rib has just one vertical support.

Labeling

Before disassembling your canopy frame, clearly label its various segments. The KK people sell color-coded and numbered waterproof labels for this purpose. Take pictures and/or notes for reassembly.

Set Up

If the canopy's vertical supports clamp to deck stanchions and/or railings, disassemble the ridgepole, pocket braces and skirt. Don't disassemble the ribs. Fit plastic end plugs and protective rubber tips at one end of two lengths of EMT; clamp the tubing to opposing stanchions (rubber tips down). Clamp the appropriate rib to the vertical supports and adjust rib height as desired. Repeat this process until all the ribs have been clamped in place. Fit the canopy's ridgepole, pocket braces and skirt. Then mark, bend, cut and clamp each vertical support (**Figure 8**).



(top left) My good friend, Tom Kauffman, persevered throughout my frame-building project. Here he's fitting the final vertical support for rib #7. Notice how the ladder on the left has been slipped in under the canopy frame. There'll be no need to cut an access door in the shrinkwrap. (above) With the completed frame in place, the foredeck, side decks and cockpit are unobstructed. (bottom left) When setting up the frame on deck, we used sawhorses to hold each rib pair securely as vertical supports were being attached. If you don't own suitable sawhorses, make your own using electrical conduit (EMT), Kover Klamps and rubber tips.

(top) Using a single piece of shrinkwrap, Dan Hughes (left) and Mike Myers of Gem Polishing, Deale, Maryland, covered the frame in just two hours. (middle) Kover Klamp's reusable protection pads are made of a heavy-duty non-absorbent, non-chafing material. Corner snaps make the pads easy to fit or remove if clamp adjustments need to be made. Waterproof, color-coded and numbered labels, like the one seen here, simplify frame reassembly. (bottom) With the cover in place, the author makes final adjustments to the lines securing the frame to the boat. Tie down lines run inside each rib and under the boat's keel. Clear plastic tubing protects the line from chafe as it exits from the bottom of the rib.

Figure 10 Cost of materials. (Kover Klamp components are in red)

Frame Component	Quantity	Price	Total
Clamps (5/pack)	33	19.99	659.67
Couplings (5/pack)	8	6.99	55.92
Slide locks (5/pack)	6	7.25	43.50
Plastic end plugs (25/pack)	1	5.50	5.50
Rubber tips (5/pack)	3	4.95	14.85
Protection pads (2/pack)	11	6.50	71.50
Electrical conduit (EMT) 19mm (3/4") x 3m (10')	100	2.19	219.00
Line, 4.7mm (3/16") braided (152m/500' spool)	1	110.00	110.00
Plastic tubing, 6mm (1/4") ID /foot	6	.14	.84
TOTAL COST			US$1180.78

Bending the vertical supports to conform to the rib arches enhances frame rigidity and prevents cover punctures. Install the wind braces. Don't forget to label the vertical supports prior to disassembly.

If your frame is free standing, separate the pre-assembled canopy into modules as discussed above. Lift the center module into position on deck. I found it helpful to pre-position two sawhorses (each fitted with pipe holders) on deck. The wind braces of each rib pair rest on the sawhorses while vertical supports (with plastic plugs and rubber tips fitted at their lower ends) loosely clamp to the pocket braces and wind brace at each rib. Slip a KK slide lock onto each support. After lifting the canopy to the desired height and extending the vertical supports, tighten each vertical's upper clamp. Position the slide lock immediately beneath the upper clamp and tighten both setscrews. Then tighten the lower clamp. Repeat this process for each vertical support. When the center section has been leveled at the proper height, mark and cut each vertical support above the pocket brace. Install cross bracing between all four verticals supporting the center module. Finally, secure the center module in place by running tensioned lines to cleats, perforated toerails and/or bulwark scuppers.

Repeat this process with the next module, building outward from the center. As each module is lifted to the proper level, connect the ridgepole, pocket braces and skirt (in that order). Install diagonal cross braces athwartship between vertical supports. Install diagonal braces longitudinally as warranted by local weather conditions. Install tie-downs to anchor the frame modules on deck to cleats, perforated toerails, caprail scuppers, etc. These lines must be tensioned whenever the boat is left unattended.

With all extended-canopy frames, run a tie-down line under the keel between each rib's tie-down loops. These lines too must be tensioned whenever the boat is left unattended.

Figure 9 Materials required for the author's 12mLx4.4mWx2.7mH (40'Lx14.4'Wx9'H) boat cover frame. Extended-canopy components are highlighted in blue, those unique to the freestanding support structure in red.

Structural Element	Lengths Conduit	Couplings	Clamps	Slide Locks	End Plugs	Rubber Tips	Pads
Ridgepole	6	5	8	0	0	0	0
Ribs	8	0	0	0	0	0	0
Rib Legs	16	16	0	0	0	0	0
Pocket Braces	8	8	16	0	0	0	0
Wind Braces	8	0	16	0	6	0	16
Skirt	8	8	18	0	0	0	0
Diagonals/Canopy	12	0	24	0	0	0	0
Vertical Supports	14	0	28	14	14	14	0
Center Posts	0	0	12	0	0	0	6
Diagonals/V. Supports	20	0	40	0	0	0	0
TOTALS	100	37	16	20	14	14	22

Time Line

How long does it take to construct and set up an extended-canopy frame? Under optimum conditions (fair weather, all tools and materials at hand, a paved area adjacent to the boat and two assistants), I'd estimate two to three days for a 12m (40') canopy. Subsequent set ups, where no cutting or fitting is needed, would take one to two days. Cost is directly related to a frame's size and complexity (**Figures 9 and 10**). Caution: Kover Klamps, like Tinker Toys, are addictive. Once you discover how handy they can be, you'll want to use them to build a temporary garage, workshop or greenhouse. Then you'll have to buy more when it's time to cover the boat again.

About the author: Susan Canfield is a NAMS-certified, SAMS-accredited marine surveyor in Annapolis, Maryland. A frequent DIY contributor, she also teaches marine surveying at WoodenBoat School in Brooklin, Maine.

UNDERSTANDING VENTED LOOPS

How many vented loops are there on your boat? Where are they located? When were they last serviced? If you've answered, "What's a vented loop?" or "I don't know," read on. Doing so could save you considerable heartache and big bucks.

STORY AND PHOTOS BY SUE CANFIELD

To be effective, a vented loop must be installed above the maximum-heeled waterline, at the highest point in the hose run.

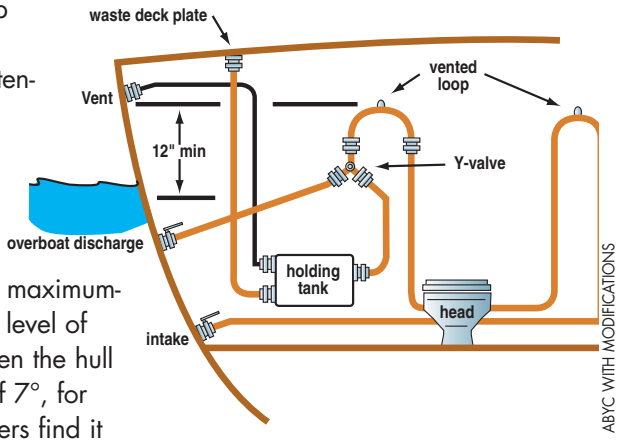
Vented loops, also known as siphon breaks, are essential components in many marine plumbing systems. They prevent back flooding, due to a natural phenomenon known as the siphon effect, which can drown a propulsion engine or generator or sink a boat.

The physics behind a liquid's tendency to flow is related to both gravity and pressure. Gravity causes liquids to flow downhill. However, liquids also tend to flow from high pressure toward low pressure. "Siphon" refers to the ability of a liquid to flow uphill through a looped hose (or pipe) when one end of that hose is lower than the liquid level. The liquid rises inside the hose because pressure decreases with altitude and the weight of any liquid in the descending portion of the hose further decreases the pressure inside the rising portion. This siphon effect can lift water up to a height of approximately 9.1m (30'), at which point pressure at the top of the loop reaches zero.

Each of the loops above is intended for installation with 19mm (3/4") ID hose (left to right top to bottom): Wilcox Crittenden, Forespar, Buck Algonquin, and Groco. Before buying, it's a good idea to disassemble several different loops to see how their valves work.

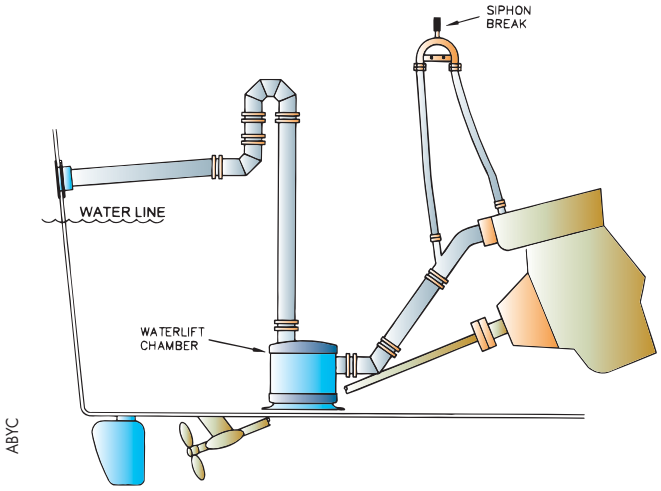
On boats, siphoning is potentially a hazard with any hose plumbed to a thru-hull fitting below the waterline, if the other end of that hose is also located below the waterline. Affected plumbing systems include, but are not limited to: the cooling water injection line on propulsion engines and generators where the exhaust manifold is located below the waterline; intake and discharge lines plumbed to toilets located below the waterline; and bilge and sump pumps.

In evaluating the potential for siphoning, be sure to use your boat's maximum-heeled waterline rather than its static (floating) waterline. ABYC defines maximum-heeled waterline as "the level of the water on the hull when the hull is inclined to an angle of 7°, for powerboats. Many boaters find it hard to imagine that their boats could be inclined to that angle and don't consider the hazard a real one. Unfortunately, many boat builders subscribe to the same fantasy. Marine surveyors will testify to the damage they see when a powerboat takes on water while tied to a dock and when subjected to a beam sea or wind action. This "inclined" the boat so that thru-hull fittings installed just above the waterline were, for some time, put below the waterline. For sailboats, the maximum-heeled waterline is at the level of the sheer amidships. Sailboats experience water at this level when they are excessively heeled under sail but other combinations of



ABYC WITH MODIFICATIONS

A MSD located below the waterline should have vented loops installed in both its intake and discharge lines. If necessary, a U-trap can be used in the intake line near the toilet to prevent a loss of prime at the suction pump due to air being drawn in through the vented loop. With electric suction pumps, a solenoid valve may be needed to close the vented loop's air valve whenever the MSD is flushed.



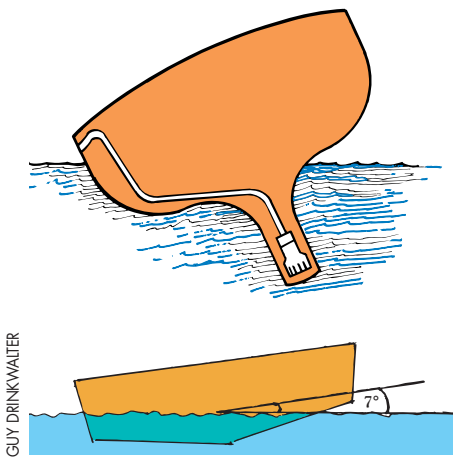
From ABYC P-1, Installation of Exhaust Systems for Propulsion and Auxiliary Engines. Whenever an engine's exhaust manifold is below the waterline at any angle of heel, a vented loop (siphon break) should be installed in the cooling water injection line.

wind and waves can put the rail down, too.

Consider, for example, your boat's electric bilge pump system. If the pump and its discharge thru-hull fitting are both located at or below the maximum-heeled waterline (even if only under extreme circumstances), the potential for siphoning exists and a vented loop should be installed. Unless a thru-hull fitting is well above (e.g., 20cm to 30.4cm/8" to 12") the maximum-heeled waterline, a vented loop is simply cheap insurance in the event of unexpected immersion due to heavy seas, overloading or flooding not attributed to the siphon effect.

Installation

While vented loops on boats built in the Far East are often made of stainless steel, those widely available in the North America are typically cast bronze or nylon reinforced plastic. To be effective, a vented loop must be installed above the maximum-heeled waterline, at the highest point in the hose run. Vented loops prevent siphoning by allowing air to enter the hose and the system then pressures to equalize.



Maximum heeled waterline as defined by ABYC is rail down for sailboats, 7° for powerboats.

If the vented loop in an exhaust system's water injection line tends to spit corrosive saltwater all over the engine, replace the valve with a barbed fitting, then attach a hose that is vented well above the waterline, such as into a cockpit locker. Likewise, if the vented loop in a waste discharge line emanates foul odors into the boat, replace the valve with a barbed fitting and attach a hose that's vented overboard, well above the waterline.

Maintenance

Since vented loops are typically located behind joinery or at the top and/or back of lockers, they are largely out of sight and, unfortunately, out of mind when it comes to maintenance. This can pose a serious problem as the valve in a vented loop can get plugged with salt crystals and become inoperative. At least annually, check these valves, unscrew and clean. Marine insurance companies typically do not pay for damage that results from a boat owner's "failure to maintain." In the event your engine fills with water or your boat sinks due to a vented loop's clogged valve, your damage claim could well be denied if you haven't met your maintenance responsibility.

So, if you haven't already answered the questions posed earlier, be sure to do so on your next visit to your boat.

About the author: Susan Canfield is a NAMS-certified, SAMS-accredited marine surveyor in Annapolis, Maryland. A frequent DIY contributor, she also teaches at WoodenBoat School in Brooklin, Maine.

SAIL BOAT RIGGING

LOW-DRAG PROPS

Follow these guidelines to inspect a folding prop for damage during the next haul out.

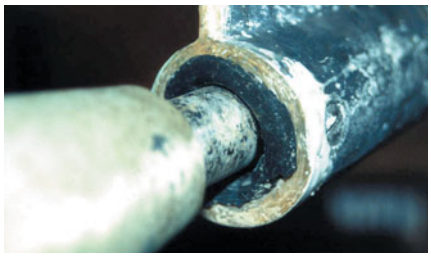
STORY AND PHOTOS BY HARRY SWIECA

Folding propellers, often referred to as low-drag, are typically installed on boats whose owner wants to tweak speed under sail by minimizing drag from a fixed prop. Although folding propellers vary in blade size, pitch and gearbox ratio, they all have one thing in common: under sail the forward motion of the boat collapses the hinged blades to streamline the running gear. By minimizing drag in this manner, you can increase sailing speed by up to a full knot. You know when a fixed-blade prop is damaged but it's not so easy to determine when a folding prop isn't at its best.

Sure signs that something is wrong with the folding blades include loss of top speed, poor performance in reverse and excessive hull vibration while under load. Since repairing a folding prop requires removal and considerable expense, it's important to confirm that the prop is worn enough to warrant the repair.

Examination of the prop begins

Blade clearance between the edges of the blades should be at least 6mm (1/4") on a Martec prop. (bottom) The two blades should lay parallel, the gap the same at the tip as at the base.



with a pressure wash and scraping to clean the entire prop and shaft area. Visually inspect the shaft for corrosion or pitting. If the sacrificial zinc is dissolved, replace it. Inspect the shaft support strut for damage. Move it side to side to see if it's loose. Grasp the prop and shaft and lift upward while viewing the cutlass bearing (see photo above). If the clearance between the shaft outside diameter and the inside diameter of the rubber insert is more than 1.5mm (1/16"), the cutlass bearing is worn and needs replacing. [Ed: For complete step-by-step details on replacing a cutlass bearing refer to DIY 2002-#1 issue.]

Close the blades and inspect for a gap between the inside of the blade tips. They should not touch.

Inspect the prop blades and hub. The hub should be secure with no movement on the shaft. The blades should be void of dents and chips. Close the tips of the blades and grasp them at the very end. The gap between the inside of the blade tips should be approximately 6mm (1/4"), though this distance varies with the brand. If the blades are touching, the blade stops are worn.

While holding the end of the blades, rotate the

To check for center pin and hub wear, hold the tip of the blades together and then lift and slowly rotate the blades in a circle. Movement indicates a worn pin and hub.

If the hub and pin are worn the hub will show a gap between the blade core and hub.

tips in a circle. If they rotate, the center tabs and pins are worn. Finally, open the blades and push them as far forward as possible. Turn the blades so they are paralleled with the strut. When viewing from the side, the leading edges of the blades should not exceed the centerline of the hub. If they do, the blade stops are worn.

If your prop failed two or more of these tests, it's time for a rebuild. Unless you are experienced with folding prop removal and you have the right types of tools such as an extended jaw puller and a very large adjustable wrench, I suggest commissioning a repair yard to perform the job. If the prop is not removed or installed properly, your engine or transmission could be damaged. To bring the prop back to original specifications, send it to the manufacturer for repairs. When the prop is returned, record the new dimensions for use as a baseline during your next inspection.

seaworthy
DAMAGE AVOIDANCE

Why Outboard-Powered Boats Sink at the Dock

Any boat can, theoretically, sink in a heavy rain storm. But a recent *Seaworthy* study found that this is the most common reason outboard-powered boats sink at the dock, accounting for 47% of sinkings.

Here's why: Most outboard-powered boats typically have low freeboard (distance from the gunwales to the waterline), large cockpits and just a couple of drains aft to carry water overboard. In a heavy rainstorm, water can quickly back up and flood the cockpit, especially when drains are full of gunk. The additional weight then shoves the stern down and water begins to flood back through the drains.

What can you do to stop your boat from sinking in a heavy rain, besides moving to Arizona? For one thing, drains should routinely be cleared of debris (use a water hose with a lot of pressure). The best defense, however, if you think your boat is vulnerable, is to keep water from getting into the cockpit in the first place. Keep a cover over the cockpit so that rainwater (or snow) is directed overboard.

Another 20% of dock sinkings were caused by failed underwater through-hull fittings, the majority of which were plastic. (The latter do not meet the American Boat & Yacht Council standards and were likely added by dealers or do-it-yourself owners. Only bronze or Marelon fittings meet the standards for use below the waterline.) A recent marine insurance claim involved a plastic fitting on a 23-foot fiberglass fishing boat that, according to the surveyor, became brittle and broke. The boat itself had been well maintained. The through-hull leaked into a small area of the bilge until the weight of the extra water forced the cockpit scuppers under and the boat sank.

Don't be penny wise and pound foolish. Plastic through-hulls are easily broken and should be replaced with bronze or Marelon fittings. The latter are much sturdier and the difference in cost is only a few dollars.

A significant number of boats also sank at the dock due to problems with live wells, which are a common feature in fishing boats. Live wells are often plumbed to an underwater through-hull fitting to bring water into the box and sometimes have drains that empty into the bilge (a poor arrangement, as anyone with a nose can attest). All it takes is a leaking fitting, loose hose clamp, or a cross-threaded seacock for the live well to allow seawater into the bilge. At this point, it's only a matter of time until the bilge pump quits and the boat sinks.

Other potential problems occur with hardware-store PVC valves, through-hulls with no seacocks, and installations that allow back-siphoning into the live well. A couple of sinkings were embarrassing — forgotten drain plugs. Tying your drain plug to your boat's key is an easy way to avoid being red-faced at the launch ramp.

Above-waterline fittings accounted for 10% of dock sinkings. Many owners install new four-stroke engines to replace the two-stroke engines that came with the boat, but four-stroke engines are heavier and will force a stern down further into the water — maybe far enough that the self-bailing cockpit scuppers are at the waterline. Rain or a forgotten cooler could be just enough to force the scuppers under and sink the boat. Other sinkings were attributed to a leaking jack plate, a missing rigging boot that allowed rain to enter the bilge, and a cracked and leaking scupper. Also, the white plastic transom fittings used for scuppers become brittle and crack in the sun — and cracks in a fitting have the same effect as a small hole in the boat. Bronze or Marelon fittings are immune to the weather and are an easy replacement.

Water from the sky—not from below—is the most common reason outboard boats sink at the dock. A partially clogged drain is all it takes to make a boat's stern heavy enough to allow water to backflow through scupper drains. The best defense (aside from hauling out) is a close fitting cover that directs water overboard.

Nine percent of all dock sinkings were caused by poor docking arrangements. In areas with significant tidal ranges and fixed docks, loosely tied boats can get the gunwale or transom stuck under a dock as the tide rises; the boat is pinned down and the cockpit drains backfill into the boat. Lines must be taut to prevent the boat from moving under the dock but also loose enough to accommodate tide changes. Crossing bow and stern lines can help. So too can mooring whips (flexible fiberglass poles that hold a boat away from the dock). There are also devices on lines or pilings that allow lines to remain taut through rising and falling tides. Chronic docking headaches can almost always be remedied by moving the boat to a larger slip.

Finally, boats that were overexposed to waves at the dock accounted for another 9% of sinkings. Most were being kept at private docks, which are often far more exposed to waves than marina docks. If the boat must be kept at an exposed dock, the bow should be facing open water. An even better alternative, especially if your boat has low freeboard, is a trailer or storage rack.

— By Chuck Fort

Subscriptions to the quarterly magazine Seaworthy *are $10 per year. For more information go to BoatUS.com/Seaworthy or call 703-823-9550, ext. 3276.*

UPGRADE

PUMP UP THE VOLUME

Perhaps you are considering upgrading the factory supplied audio system on your boat. Here's how to design an aftermarket system for a small runabout, mid-size cruiser or large yacht and install electronic components, speakers and subwoofers.

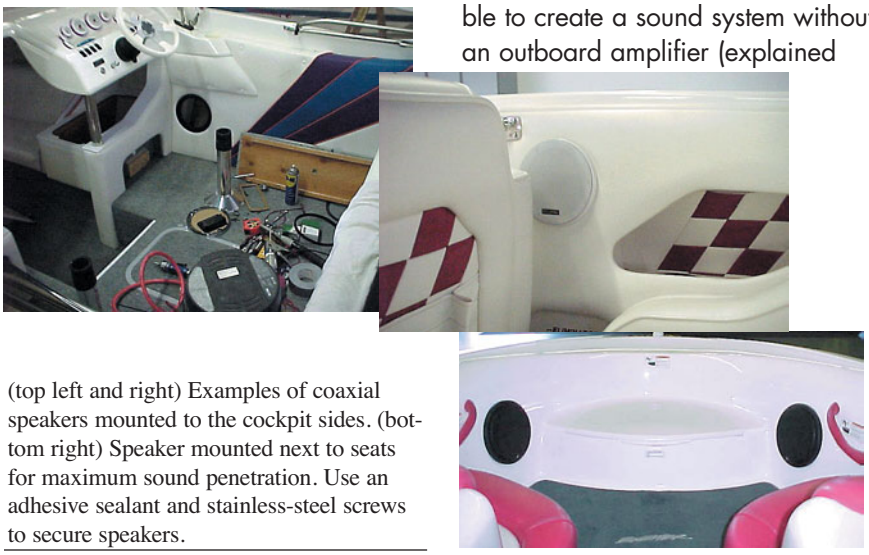
STORY AND PHOTOS BY ROBERT JANIS

You can replicate the distortion-free sound quality of a home stereo by augmenting your boat's existing audio system. Whether it's a speaker upgrade, adding a tweeter combo or a subwoofer or two, a head replacement that's satellite radio ready or a multi-channel high-watt amp. There are myriad possibilities depending on your budget and available installation space.

Let's first look at the components that make up an audio system and available features. The head unit is considered the source unit of the system. This is where the audio signal is introduced into the system. Head units include the radio tuner, a CD player or cassette player. Most head units also have the capability of controlling a CD changer. More sophisticated units can accept a satellite radio receiver (available from XM Radio or Sirius) or take in audio from a video source through an auxiliary input. This permits the addition of a DVD player or videocassette recorder. Moreover, many more expensive head units include some kind of built-in equalizer and low-pass and highpass crossover. The equalizer portion allows the user to boost or cut particular frequencies to balance the sound in order to achieve a good sound quality. The lowpass crossover feeds the low frequencies or bass frequencies to the subwoofers of the sound system. The highpass crossover feeds the proper high frequencies to the speakers that play the midrange, midbass frequencies and to the tweeters that play the highest frequencies of a sound system. Head units that include a radio and cassette player range in price from US$130 to US$240. Units with radio and CD player average US$200 to US$400.

Most head units come with a built-in, four-channel amplifier to power speakers. This makes it possible to create a sound system without an outboard amplifier (explained later). A built-in amplifier offers a minimal amount of power, perhaps 45 watts per channel or enough to power a couple of speaker pairs. Since a boat needs a lot of sound power to hear the music above the ambient noise of wind, waves and engines, the addition of an outboard amplifier would be more practical.

An outboard amplifier takes the audio signal from the head unit and boosts it, then passes it on to the speakers. There are one channel, two channel, four channel, and even five channel amplifiers available. Each channel feeds power, measured in watts, to one or a series of speakers. For example, on a two-channel amplifier, one channel



(top left and right) Examples of coaxial speakers mounted to the cockpit sides. (bottom right) Speaker mounted next to seats for maximum sound penetration. Use an adhesive sealant and stainless-steel screws to secure speakers.

TIP In the Zone

The most likely location of listeners should be considered when mounting speakers in the cockpit.

If you want superior sound, you need to position speakers so to maximize their acoustics and provide the most direct sound path to the listeners. A speaker produces sound when its cone moves back and forth compressing air in waves that ultimately strike the ear drum. The best sound is produced along a line projecting outward from the center of the cones, its central axis. Sound also radiates approximately 45° from the main axis in a pattern that resembles a cone. If the listener is not in this radiating zone, sound must bounce off of a reflecting surface to be heard. This is not a problem in the cabin below deck but in the cockpit there are few reflecting surfaces. Cockpit-mounted speakers should be positioned in the direct listening path of the occupants.

sends power to speakers on the portside; the other channel feeds power to the starboard-mounted speakers. A four-channel outboard amplifier can feed speakers in four locations. Commonly, a one-channel amplifier, also referred to as a mono amplifier, offers power to the subwoofer or subwoofers. A two-channel or four-channel amplifier usually provides power to the midrange, midbass and tweeter speakers.

Amplifiers are offered with a variety of power ratings, defined in watts. The higher the wattage, the more the power. Some units have protection circuits that shut the device off if it gets too hot or is forced beyond its power capability and if speaker wires short out. Another protection feature is a subsonic filter. This assures that frequencies that are too low for a subwoofer to play are blocked from reaching the speaker, which could damage it. Amplifiers also come with built-in variable crossovers and bass equalizers. "Variable" means that the user can set the crossover point between two parameters. For example, a variable crossover in an amplifier allows the user to set the lowpass crossover point between 50 Hz and 150 Hz. The bass equalizer boosts the bass volume level being played by the subwoofer(s). Amplifiers range in price from US$200 to US$500.

Speakers specifically designed for boats are made of polypropylene cones, mylar tweeters and include an UV-resistant, high-impact plastic grille with water drainage channels and stainless-steel mounting hardware. A word of caution: as speakers use magnets to produce sound, sometimes the magnetic field is strong enough to have an effect on navigational electronics and compasses.

Component sets are available, which include a pair of 16.5cm (6-1/2") midrange speakers and 3.8cm (1-1/2") titanium tweeters. Also available are subwoofers and coaxial speakers, which combine both speakers in one assembly. Speaker prices range from US$69 to US$200.

Many marine audio manufacturers offer a remote control. This transfers control of the entire audio system from one unit. Wired remote controls range in price from $40 to $200.

TIP Powered by Ohms

Ohm is a term that describes the amount of resistance on the wire that feeds power from the amplifier to the speaker or speakers. The higher the ohm rating, the more the resistance. The lower the ohm rating the lower the resistance and the more power that gets to the speaker.

Shop Around

There are three ways to start your search for a shop: contact the audio manufacturers who offer marine products and have them suggest a few dealers in your area; check out the yellow pages; and the Internet. Products designed for automotive use can be appropriate for use on your boat. Moreover, installers of audio systems in cars are familiar with the harsh environment a moving platform can offer and have come up with skillful ways to securely mount and

A bench seat or a storage cabinet doubles as a good location for the subwoofer. (top left, clockwise)To cut the hole, tape or support the woofer in place and trace the inner circle of the speaker (within the mounting frame). Cut the hole within the marked circle. (far left) More examples of subwoofer installations.

A panel makes a good location for a coaxial speaker.

In this case, the amps are screwed down to a carpet-covered Ozite board mounted in a storage compartment. Notice the wires are tied together with wire ties to assure a clean installation.

A tower is the perfect mount for speakers. These speakers from MB Quart were custom installed in enclosures then mounted on stainless steel brackets that bolt to the tower. All speakers face toward the back of the boat.

A wired remote control could be mounted just about anywhere in the boat. This allows the user to control the sound system from the cabin, not just the cockpit where the head unit is probably mounted.

A large nook like this one stows the head unit, a speaker and amplifier. The compartment is away from water, dry and sealed. Fans were installed to cool the amplifier.

protect products from the elements.

Then there are some of you who are do-it-yourselfers who may be looking for a project to take up some time on a Saturday or Sunday afternoon. Those of you who are familiar with electronics and installation can buy the equipment from a reputable audio specialty store and then do the installation of the equipment yourself. Visit the store. It should have marine products prominently showcased on display. Ask the salesperson about the marine products the store offers and how long the store has been catering to marine customers. Ask to see photos detailing the work it's done on boats. It there aren't any, move on. Ask if the shop has the capability of having an installer travel to your boat. Many shops don't send out their installers to the boat for insurance reasons. You may have to bring a trailerable boat to the shop to have the work done. Choose the shop based on the answers you get and how comfortable you are with its personnel.

Design Planning

"Designing an audio system begins with you making a wish list of what you want the system to do," noted Isaac Goren, owner of Sounds Good Stereo and Marine, Woodland Hills, California. Issac has been involved in the car audio market for more than 20 years and he is a pioneer in the retailing and installation of products for boats.

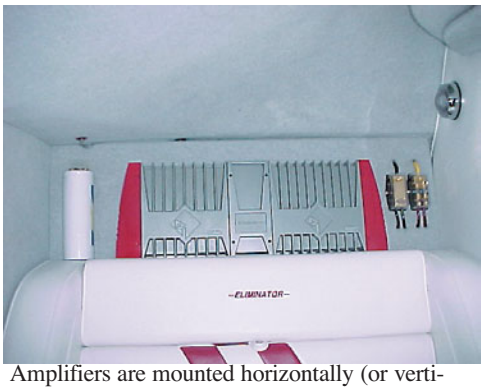
Do you want a head unit that plays just CDs or do you want a head unit that plays cassettes and controls a CD changer? How loud will you be playing the system? Do you want satellite radio? Where do you want the music heard? Do you want to control the system from more than one location onboard?

Issac suggests choosing a head unit or amplifier with a built in low-pass and highpass crossover and equalizer to eliminate the need for additional outboard components. A four- or five-channel amplifier, which is 2 ohm stable (refer to definition on page 51), is the most efficient. The 2-ohm stable provides enough

Wires should be tied and secured. A very neat job!

Head unit securely mounted. An optional plastic cover fits over the unit to protect it from water.

Speakers can be covered with grille cloth to provide esthetics.



Amplifiers are mounted horizontally (or vertically) in an area that is dry and well ventilated. A capacitor (shown on the left) assures that the amps get continuous power. Fuses appear at right.

power to feed energy to the speakers through an extremely long run of wire. With a four-channel amplifier, the front two channels play the mid and high speakers with a highpass crossover and the rear four channels are bridged to play a subwoofer with a lowpass crossover. Boats with a multiple cabins often need two or more amplifiers to play speakers in the main cabin, aft cabin and master bedroom.

Walk through your boat and decide where to install the components. You'll need to locate a dry storage area for mounting the amplifier. Also, check that there is access to route wires from the amplifier to each selected speaker mounting. You'll need to determine the length of wire runs from the amp(s) to the speakers. More important is the length of the power and ground cables to the amp. This may influence your decision of where to install the amplifier. Make a sketch that shows the locations of all components, the routing of wires and cables. This way you'll know exactly what you need and where everything goes long before you start the installation.

If your boat is equipped with a single battery bank, you should add another battery. This way one battery is dedicated to engine starting and the other one, a deep cycle battery, to power the audio system, electronics, etc. Some boats may also need upgrading to a high-output alternator to replenish the extra drain of the audio equipment.

TIP Sample Systems

Runabout (no cabin)
Head unit with equalizer
4 16.5cm (6-1/2") coaxial speakers or 4 16.5cm (6-1/2") speakers with tweeter and mounted to the cockpit sides near seats
1 Four-channel amplifier with a highpass and lowpass crossover
1 25cm (10") subwoofer mounted under a seat or bench

Mid-size Cruiser, Cuddy Cabin, Daysailer
Head unit with equalizer in cockpit
2 four-channel amplifiers in cockpit
4 16.5cm (6-1/2") coaxial speakers or 16.5cm (6-1/2") speakers with tweeters placed in the cockpit near the seats
1 25cm (10") subwoofer placed under a seat in the cockpit
2 16.5cm (6-1/2") coaxial speakers placed in the cabin
1 25cm (10") subwoofer placed in a bench or seat in the cabin
1 wired remote control

Multi-level Yacht
Head unit with equalizer in cockpit
4 16.5cm (6-1/2") coaxial speakers or 4 16.5cm (6-1/2") speakers with tweeter and mounted to the cockpit sides near seats
2 four-channel amplifiers with a highpass and lowpass crossover
1 25cm (10") subwoofer mounted under a seat or bench in the cockpit
4 16.5cm (6-1/2") coaxial speakers placed in the cabin
1 25cm (10″) subwoofer placed in a bench or seat in the cabin
1 four-channel amplifier mounted on the flybridge
4 16.5cm (6-1/2") coaxial speakers on the flybridge
1 25cm (10") subwoofer on the flybridge
2 wired remote controls

Model Systems

You start with a basic system for small boats and then keep building, adding components as the size of boat increases. For small runabouts without a cabin, Issac suggests having four speakers spread out and mounted as high as possible. This could be a coaxial or midrange with tweeter and subwoofer. Storage area under a seat or bench is easily converted into a speaker enclosure and the front portion cut out to accommodate the speaker cover. A subwoofer is commonly installed in the main cockpit seating area. Many newer boats come with four

(above) Sounds Good Stereo installer wires three MB Quart 8-inch two-way coaxial speakers on to a side panel of a ski boat. The panel was removed from the boat, the speakers were mounted on it and then the panel was reinstalled (left). That's plenty 'o sound mon!

Sources

Alpine Electronics
800/421-2284; www.alpine-usa.com

Audiovox Specialty Applications
800/688-3135; www.asaelectronics.com

Babb
800/892-2221; www.babbspeakers.com

Bose
800/999-2673; www.bose.com

JL Audio
954/443-1100; www.jlaudio.com

JVC
800/252-5722; www.jvc.com

Kenwood Marine Audio
800/456-3340

Marine Audio Engineering & Sales
800/754-9876; www.marineaudio.com

Maxxima Marine
631/434-1200

MB Quart
800/ 962-7757; www.mbquart.com

Ocean Equipment
949/588-1470; www.oceanequipment.com

Pioneer Electronics
800/421-1404; www.pioneerelectronics.com

Poly-Planar
215/675-7805; www.polyplanar.com

Prospec Electronics
800/394-1914; www.prospec.com

Sony Marine
800/ 844-2774; www.cpsdistributorsin.com

Sounds Good Stereo and Marine
818/999-4523; www.sounds-good-stereo.com

speakers. So to upgrade, just substituting these speakers with aftermarket speakers will be sufficient without cutting any holes. A dry place under a seat, underneath the helm or behind a panel is ideal for mounting the four- or five-channel amplifier. Where there's adequate dry storage you can add a six-disc CD changer. The new head unit likely fits in the cavity that housed the factory head unit. If not, you'll need to resize the hole or reposition on the helm.

A mid-sized cuddy, daysailer or weekender with a cabin has the same components in the cockpit as mentioned above for the runabout. For interior sound, add

(left) Compartment constructed of medium-density fiberboard covered with fiberglass on the outside and carpet on the inside to serve as a mount and protection for a CD changer. (bottom) A custom panel holds two 6x9 speakers.

A CD changer control in a custom-made enclosure and mounted to a cabin bulkhead.

a four-channel amplifier to power two coaxial or midrange with tweeter speakers mounted on the cabin ceiling, and a subwoofer installed under a bench in cabin and another one hidden in a protected cockpit locker. Adding a wired remote control in the cabin gives control of the audio system there rather than from the cockpit.

Audio installations on larger boats with several levels are more complicated. You'll have to decide whether you want each level to be wired for sound. The main cockpit or lower helm station is set up like the small runabout, the main saloon equipped like the cuddy cabin. The flybridge typically includes two to four coaxial speakers and one subwoofer with a four-channel amplifier. A wired remote control for each level of the boat transfers complete control to the user. If your boat has an AC electrical system you can include 110-volt home audio products in protected areas in the cabin away from water.

Installation Tips

Tools and materials needed to perform the installation include a jigsaw, drill with bits, stainless-steel screws and bolts, sealant, marine-grade tinned stranded copper wire and terminals plus a wire stripper, crimper, heat-shrink tubing to guard against corrosion and heat gun. Cable and wire sizes are based on ABYC recommendations and determined by the length of the run and a 10% voltage drop. Wires routed through an engine compartment will need to be larger. [Ed: refer to voltage drop tables in DIY 1998-#4 issue or the MRT "DC Electrical Systems" CD-ROM.]

Most likely you'll have to route wires behind a bulkhead, gunwale or cockpit sides. Use an electrician's snake or a bendable rod, referred to as a "fishing tool," to accomplish this. Take advantage of access holes already present, such as drink holders, and remove them as needed. Cutting out the holes for speakers before you route wires provides another access hole for fishing the wires. Bundling wires in split loom tubing, especially in the engine compartment, gives a professional finish and helps guard against heat and water. Cable tie all wires so they don't hang loose. Be sure to include an inline circuit breaker (or fuse) for the head unit and amplifier.

When mounting the amplifier, be certain that the heatsinks are properly configured on the top. Their location on the highest part of the amplifier is no accident. Heatsinks are made of metal and draw out the heat generated from the amplifier. Don't just rely on screws to hold the amplifier in place. Instead, mount it to a strong board, like Ozite or StarBoard that is then securely screw-fastened and sealed with an adhesive sealant (e.g. 3M 4200). Fashion cleats if needed to reinforce the edges. For complete security, thru-bolt the amp to the board.

Speakers need adequate air space behind them, at least 30.4cm (12") on all sides. As the speaker cone (see "In the Zone" on page 50) moves forward, it creates a vacuum behind it. As it moves back, it compresses air. If the air cavity is too small, cone movement slows in both directions. Bass response is also lost since low frequencies need more air movement. When speakers are mounted with a huge void behind them bass response is further diminished making them sound tinny. In this situation, always mount speakers in an enclosure.

About the author: Robert Janis is a freelance writer who has covered the car and boat audio and audio-video industry for more than 19 years.

Poly-Planar marine speakers have a low magnetic field intensity that reduces interference with navigational electronics and compasses.

DIY Bill

Materials

Cost of materials in U.S. dollars for installing an audio system (does not include stereo components):

• Small runabout	$100
• Mid-size cruiser	$425
• Large multi-level cruiser	$750

Labor

• Small runabout	5 hours
• Mid-size cruiser	16 to 24 hours
• Large multi-level cruiser	24 to 40 hours

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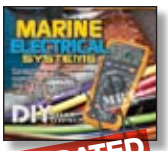

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The complete guide to painting and refinishing hulls, topsides and decks with marine coatings.

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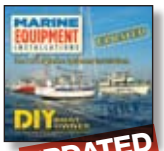

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PROJECTS

Indicates the level of difficulty with 10 being the hardest, 1 the easiest.

1

CRUISE-READY TACKLE

9

Production boats are not always well equipped to enable boaters to handle and stow multiple anchors and rodes. Here's how one owner designed, fabricated and installed an anchoring system complete with bow rollers, a windlass and anchor locker.

STORY AND PHOTOS BY SANDY TURNEY

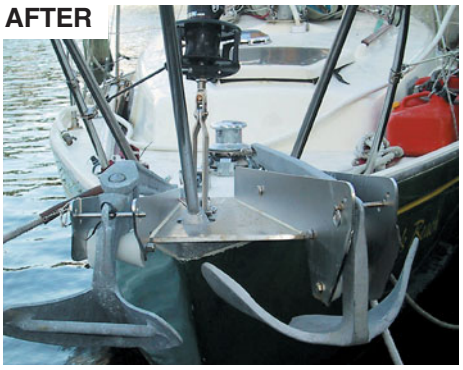
After years of reading and research, I decided that I needed two anchors on the bow of "Sandy's Beach," my Contessa 26, when cruising the Bahamas and anchoring with a Bahamian mooring. A Bahamian mooring requires two anchors to be set 180° from each other to allow the boat to pivot when the tide changes. Since my boat was not designed with a bow roller, windlass or chain locker, I had a real challenge accommodating my need.

I had decided on a manual Simpson-Lawrence Anchorman windlass with 8mm (5/16") chain gypsy and capstan. Primary anchor would be an 11kg (25lb) CQR, secondary anchor a 10 kg (22lb) Bruce, both with all chain rodes. The design needed to incorporate my odd cast-aluminum stemhead fitting, both anchors, Kingston bow rollers for each anchor and leading all in a straight line to the windlass. This required fabricating a custom stainless-steel plate to fit over the stemhead that wouldn't interfere with the forestay connection points and that would hold both bow rollers. The design had to ensure that anchors would avoid the roller furling drum, the hull and each other when resting on bow rollers. I needed clearance for kneeling on deck and cranking the windlass without hitting anything. The chain locker below would need two compartments to hold both chain rodes and it had to include a drain.

Deck modifications included cutting off the existing stemhead chocks and reinforcing the foredeck to support the added weight and anticipated loads of the stainless plate, anchors, rollers, windlass and chain locker. The design also required moving the bow light from the stemhead with installing a new one on the pulpit rail. I needed to decide where to mount the new bow chocks, the chain pipe for anchor rodes and the anchor stopper.

BEFORE

AFTER



1

Making the Pattern

Using the stemhead fitting, which I removed from the boat, and my foredeck measurements, I recreated my foredeck on paper (**Figure 1**). I used foam board (available at office supply stores) to make two-dimensional anchor templates to make sure the position and alignment of the bow rollers wouldn't result in the anchors hitting each other and the bow. The CQR bow roller would mount on the starboard side of the stemhead with the windlass situated about 91cm (3') aft. This provided enough space to kneel on the foredeck and crank with the winch handle. I would mount the Bruce bow roller on the port side at an approximate angle of 20° in order to use the windlass and not hit the other anchor and possibly the bow.

Based on my paper design, I cut a plywood template of the stainless- steel plate. I bolted the bow rollers onto the plywood plate and took the mock-up to my local chandlery to physically experiment with

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the anchors (I hadn't yet purchased these). I determined that I needed 25cm (10") of vertical height so I didn't hit the roller-furling drum when pulling up the anchors. To solve this problem, I had my local machine shop fabricate longer link plates (**Figure 2**). I then dry fit (**Figure 3**) the plywood plate, bow rollers and modified stemhead (the machine shop had cut off the chocks) on the boat, to determine the correct position of the rollers, the plate size and anchor location (I borrowed a friend's anchors). After adjusting the plate size, I cut another plywood template. Checking all measurements again, I made more adjustments to reduce the plate size, and then cut out a third and final template. From this, the machine shop fabricated a 9mm- (3/8"-) thick stainless-steel plate with pre-drilled holes for the bow rollers and stemhead bolts. After dry fitting this very heavy piece on the boat, it was returned to the machine shop to drill two holes for bolting the assembly to the deck.

Foredeck Mods

To reinforce the foredeck, I cut out the ceiling cabin liner and epoxy-glued 12mm- (1/2"-) thick marine mahogany plywood to the underside of the deck, and then covered the panel with epoxy and fiberglass. Before glassing in the chain locker bulkhead, I put the rode divider inside but left it unattached. I had not yet resolved how the rode and chain would fall into the locker. Both

2

3

the divider and bulkhead are 12cm (1/2") marine plywood. I made the access hole in the bulkhead big enough so that I could wiggle my shoulders into the chain locker if I ever needed to do a repair to the hull or deck inside the locker (**Figure 4**).

I covered the bulkhead with a varnished piece of 12cm (1/2") mahogany plywood with a 15cm (6") watertight access port installed. This cover (**Figure 5**) attaches to the bulkhead with bolts, washers and wing nuts, which, when tightened, squeeze a gasket around the bulkhead opening making it (in theory) a watertight seal.

Where to locate the drain for the chain locker turned out to be a much bigger safety issue. A friend was adamant that it not drain into the bilge as it might flood the boat if water enters the hawse pipes. However, I didn't relish the idea of a drain hole through the hull, especially when the locker floor was at the waterline. Instead, I installed a 19cm (3/4") thru-hull fitting and ball valve through the chain locker bulkhead with the drain hose snaking through the interior to the bilge. I installed a bilge alarm to signal when the bilge pump runs because I can't always hear it when I'm sailing or running the engine. If there's a lot of water entering the bilge from the chain locker, I can close the ball valve.

Back on deck, I filled in the vee portion of the foredeck where it butted up to the stemhead with solid mahogany strips epoxied together

4

and chamfered to fit. These are secured with 3M 4200 and painted with white Brightside. I reattached the stemhead to the boat with liberal amounts of the same adhesive-sealant and positioned the stainless plate on top of the stemhead. A layer of sealant separated the two metals and acted as a barrier layer against galvanic corrosion. A stainless backing plate and four 8mm (5/16") bolts secured both the plate and stemhead. Next, I attached the stainless bow rollers separating them from the plate with 4200. Some bolts go only through the plate but most go through the plate and deck with stainless backing plates underneath (**Figure 6**).

Pulpit stanchion bases were rebed with 4200 and stainless backing plates were installed. The Ancor Marine two conductor, double-insulated 14 AWG wire for port and starboard navigation lights was snaked through the backing plates and bases from inside the chain

5

6

locker and into the pulpit tubing. The pulpit was carefully attached so as not to pinch the inside wires. I then installed the Aqua Signal 40 port and starboard lights with a 22mm (7/8") rail clamp fitting.

Hardware Installation

Following the manufacturer's clear instructions, the windlass was easy to install. It mounts to the deck with thru-bolts and 28cm (11") diameter, 6cm- (1/4"-) thick stainless-steel backing plate (visible in **Figure 5**). Overkill? Maybe, but I'd rather over-build than overload the deck.

New stainless chocks are secured with thru-bolts and a backing plate (visible in **Figure 5**). They were placed slightly aft of the center pulpit stanchions in order that any line through the chocks would lead fair to either cleat.

Since the windlass mounted outside (aft of) the bulkheaded area in the chain locker below to allow the winch handle to clear the stanchions, positioning the two chain pipes was problematic. A line drawn across the deck slightly aft of the aft pulpit stanchions in **Figure 7** shows the area of the chain locker. Rather than the chain pipe entry passing directly beneath the windlass chain stripper, it must carry along the circle of the windlass and

7

mount on the port side of the chain locker. This resulted in the Bruce anchor chain pipe positioned on starboard and closer to the bow rollers so the chain didn't interfere when using the CQR. The CQR bow roller's centerline aligns with the starboard outside edge of the windlass. Adding an anchor swivel helps when the CQR comes up upside down. An anchor stopper mounts inline with the CQR chain just inside the chain locker, almost halfway between the anchor swivel of the CQR and the windlass. This stopper acts like a cleat, taking the pressure off the windlass. It's thru-bolted with a substantial stainless-steel backing plate.

Fine Tuning

My anchoring set up works great (**Figure 8**). I can release the CQR in seconds by pulling the roller pin that secures the anchor and the pin on the anchor stopper, thus letting loose the chain (as I had to do once on the Intracoastal Waterway).

There are some changes I would make now that I've done a lot more anchoring. First, I would raise the windlass up about 3.8cm to 5cm (1-1/2" to 2") so the chain, when stripped from the windlass, falls more easily into the chain pipe. This involves raising the anchor stopper also. Second, the bow is very heavy due to the robustness of the bow rollers, stainless plate, weight of two anchors and combined rodes of 36.5m (120') of chain. To reduce the weight forward, I plan to remove the Bruce anchor and replace it with a 7kg (16lb) Danforth with only 12m (40') of chain and hope it fits the existing roller. Removing gear from the vee berth will also lighten up the bow, but this means moving stuff further aft and other stuff off the boat.

In Retrospect

If I were to do it again, I would have a single anchor, my CQR, at the bow. Dual anchors work very well on bigger boats that can handle the weight but my boat's displacement is only 2,449kg (5,400lb). I would probably install a roller off the stern to hold the Danforth and create a small chain locker nearby in a cockpit locker. When the anchor is deployed, I could bring the stern rode around to the bow. Unfortunately, this limits the use of the windlass with the Danforth. [Ed: can be done with a fairlead system to lead the rode forward to the windlass but it would require using rope rode instead of chain. Something to consider.]

I would also purchase used items rather than buying new. This substantially reduces the cost of the refit as I spent way too much money relative to the size of the boat.

Reading and research is good, but nothing beats actual practice. I have found that I don't need two anchors on the bow of my Contessa 26 when cruising the Bahamas, as I once thought; one anchor at the bow and one on the stern is really all the weight a Contessa 26 should carry.

8

About the author: Sandy Turney is now cruising aboard "Santana," her boyfriend's Chris-Craft 35 Caribbean Ketch. She is waiting out the 2003 hurricane season taking Spanish lessons and doing boat maintenance in Luperón, Dominican Republic. "Sandy's Beach" is on the hard in Brunswick, Georgia.

DIY REPAIR BILL

Prices are in U.S. dollars (2001), tax excluded. Cost of rope rodes is not included.

Kingston CQR-20 bow roller	$200
Kingston CL-25 bow roller	$140
2 chain pipes	$53
Stainless-steel bow plate	$400
28cm (11") diameter stainless-steel backing plate	$40
2 stainless-steel link plates	$100
Machine shop labor to remove chocks from stemhead	$40
19cm/3/4" brass thru-hull, ball valve, hose barb and hose	$60
Miscellaneous backing plates, bolts, sealant	$100
Plywood, fiberglass, epoxy, paint, etc.	$133
Simpson-Lawrence Anchorman manual windlass	$550
11kg (25lb) CQR	$370
10 kg (22lb) Bruce	$150
2 37m (60') G4 8mm (5/16") chain	$215
46m (150') 16mm (5/8") nylon rode for CQR	NA
46m (150') 12mm (1/2") nylon rode for Bruce	NA
Anchor stopper	$55
Anchor swivel	$55
TOTAL	**$2661**

ENGINE SAVER

7

This monitor prevents overheating when cooling water stops flowing due to an obstruction.

Garbage bags, seaweed, debris, a worn impeller or malfunctioning water pump can all restrict the flow of cooling water to your engine. When this happens, the operating temperature rises quickly and the damage can be done before the engine alarm sounds.

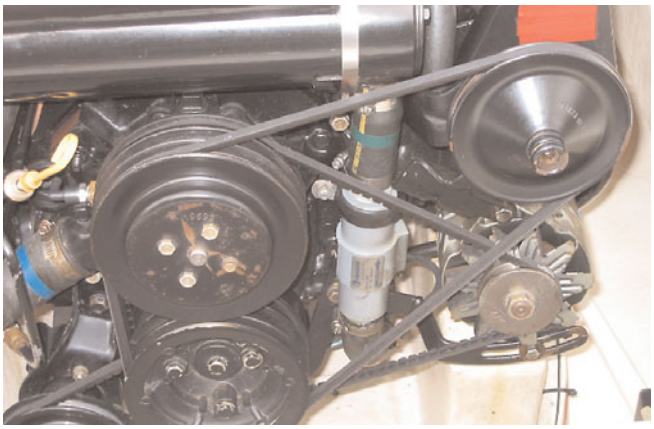
This happened to my neighbor's powerboat when the sterndrive became fouled by a bag. The thermal alarm sounded too late to save the engine. I'd heard of other occurrences and wondered why there wasn't an alarm on the raw-water intake. Wanting to save my boat's stern drive from a similar fate, I began searching for such a device. There are a few available, but only one that I considered affordable.

The Engine Saver Kit (US$89) from Aqualarm Marine Safety Systems (Tel: 888/298-6206, Web: www.aqualarm.net) consists of a single hard-plastic tube, about the size of a shaving cream can, which mounts inline with the raw-water intake. Operation is simple. Water pushes on a metal ring that disconnects the circuit. Should water stop flowing while the engine runs, the circuit opens to trigger a red dash light alert and audible alarm included in the kit. You'll need to purchase two 25mm (1"), threaded male hose connectors with a hose barb on the other end of the same diameter as the water hose.

Simple to Install

Installation consists of three components: the dash light assembly, the device itself and a wiring harness. I choose to eliminate the horn to simplify the installation. [Ed: the "belt and suspenders," dual alert system provided by the manufacturer is preferred since a light may not always be sufficient to grab your attention when needed.]

Drill a 5mm (3/16") hole in the dash for the bulb. Connect a positive (purple) wire from another instrument so the alarm is powered off the ignition switch. A negative wire leads to one of the two ground wires on the device. Cut the raw-water line somewhere between the



Unit installed in raw-water hose on author's Mercruiser. Note flow direction prominently labeled. The author uses colored tape to mark the hoses: green tape for raw-water hoses, blue tape for freshwater coolant hoses. Wires are behind the Aqualarm, neatly added to the pre-existing alternator (at right) bundle. (top) Warning light on dash.

intake thru-hull and the heat exchanger for freshwater cooling or the intake and the impeller if raw-water cooled but after the water strainer, if equipped. I choose a location just beneath the engine block that runs straight up into the heat exchanger intake. (The device is slightly more sensitive if the circuit contacts fall vertical with gravity.) Cut the hose and remove about 20cm (8") or so. Securely thread the needed hose connections onto the device, using Teflon tape. My Mercruiser needed hose connections with a 3cm (1-1/4") diameter hose barb on each end. The barb ends connect to the raw-water hose with all-stainless-steel hose clamps. The other green wire connects to the boat ground; in my case, the engine block.

Operation

Turn on the ignition key and, if all is wired correctly, the red light should shine. Crank over the engine and the light flickers at idle (700 rpm) but disappears when advancing the throttle to 800 rpm, verifying alarm function with every use. With this sensitivity, I'm glad not to have the horn screeching.

About the author: Dr. Dan McDougal purchased a Parker 25 Sport Cabin hull and deck with engine installed and completely finished the boat. He uses "Dry Doc" for cruising and fishing Chesapeake Bay.

TROUBLE-FREE HEAD SYSTEM

7

When adding a holding tank to my head system, I wanted to design a simple, easy-to-maintain system that met all legal requirements.

My criterion for the system was extensive. I wanted (a) freedom from complicated or electrically powered devices and pumps; (b) holding tank capacity for a weekend for four people; (c) direct discharge options; (d) the ability to lock the system into containment mode to comply in no-discharge areas; (e) both deck fitting and overboard pumpout options; (f) no maintenance, clog-free plumbing; (g) minimal space requirement and, of course, (h) low cost. Of course I started with (a).

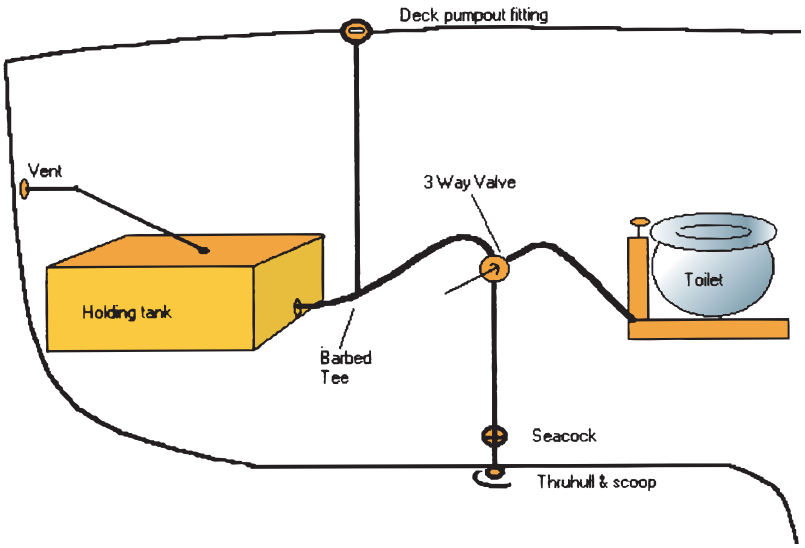
No electrics minimizes problems with the marine sanitation device (MSD) and hand pumping decreases the freshwater needed for each use. I opted for a name brand manual toilet, one model I'd already had good experience with and knew how to disassemble should the need arise.

As for the holding tank, I choose a heavy wall polyethylene unit of the largest size available that fit the allotted space. This system requires that the tank have an opening at the lowest point on one of the end panels or sides but not in the bottom. It also requires a valve that can connect any two of the three openings. Some three-way valves require grinding or cutting off a stop so the handle revolves completely. (Tee-shaped models usually won't work because they can only connect openings A and B, or A and C but not B and C.) A removable or lockable handle is useful for no-discharge areas. Other items include a scoop strainer to fit over the discharge hull fitting, sanitation hose or Schedule 80 PVC pipe, clamps, barbed fittings, barbed tee, vent hose, vent fitting, deck plate and Teflon tape and siphon

breaks, if needed. [Ed: refer to article titled "Understanding Vented Loops" on page 46 in this issue.]

Installation

As many boats likely have some of the head components already installed and usable, for this discussion I'll presume that the MSD is mounted and its intake connected with or without a vented loop [Ed: refer to article titled "Understanding Vented Loops" on page 46 in this issue] to an intake thru-hull and seacock. From the MSD discharge runs a piece of sanitation hose to one of the three ends of the selector valve. Another of the selector valve ends connects with sanitation hose to an opening in the lower section of the holding tank. A barbed tee intersects this hose and the remaining connector attaches to the deck pump-out fitting. The third opening on the selector valve connects with sanitation hose to the discharge thru-hull, with the opening aft. Finally, the holding tank is vented through the hull topsides or other chosen location.



Operation

In operation, the three selector valve positions can: connect the toilet with the thru-hull for direct discharge; connect the toilet with the holding tank for holding operation; or connect the holding tank with the thru-hull for overboard pumpout (direct discharge). In this position, the boat must be underway to suck out the tank contents. Additionally, in the direct-discharge position, the tank can be pumped out through the deck plate.

Fine Points

Presuming you have the resources to complete the installation of the head, plumbing components and holding tank, some details are worth mentioning.

Use seacocks on all below-waterline thru-hulls and double-clamp all hose connections below the waterline. For obvious reasons, position the discharge thru-hull on the opposite side of the intake thru-hull. Surely, mount the holding tank vent away from hatches, portholes and the cockpit even if it means a longer hose run. And run the vent hose continuously uphill to the vent fitting, if possible. Locate the selector valve in a handy place with room for the handle to revolve completely and be removed when in a no-discharge area. Limit the distance between the toilet and the selector valve. Shorter is better with all the hoses for that matter. A MSD installed below the waterline should have vented loops in both intake and discharge lines. Holding tanks are heavy when full so strong mountings are required. Teflon tape is great thread sealant but so slippery you may overtighten and crack plastic fittings, so be careful.

After 10 years of trouble-free use, I can report that this system has exceeded all expectations. The system's simplicity is always of interest to other boaters who come onboard and its simplicity and reliability encourage its proper use.

About the Author: John Brooke is an ardent DIYer based in Centerville, Massachusetts.

Good Boatkeeping

RESTORE AGED PLASTIC PORT FRAMES

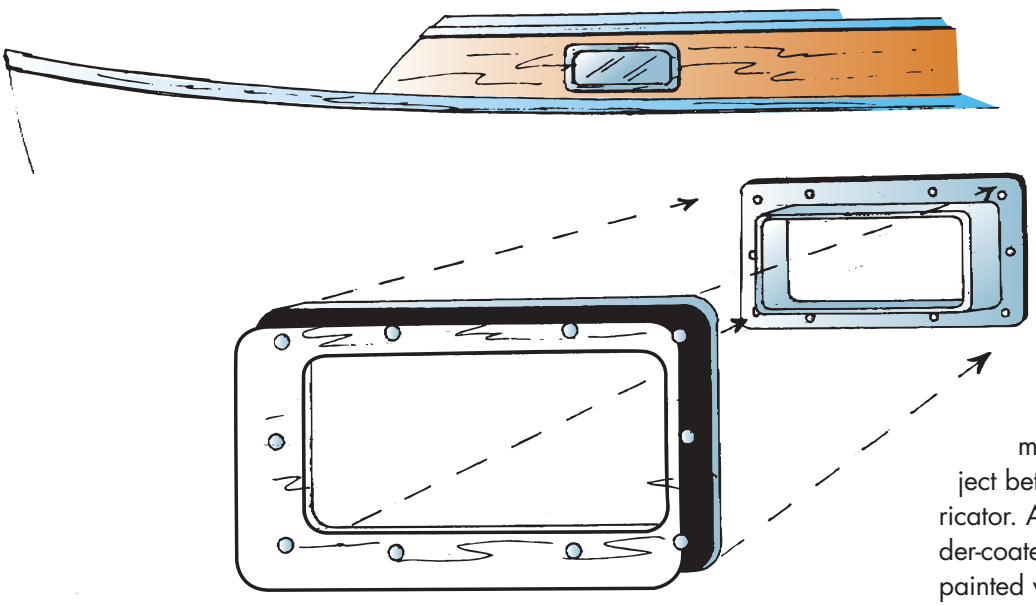
BY DAVID AND ZORA AIKEN

After many years of exposure to sun and salt, the exterior frames on plastic ports show the inevitable signs of aging. They yellow or craze or crack, none of which fits the shipshape and Bristol-fashion look. To restore a new look, the port frames can be removed, cleaned and painted. Better yet, they can be replaced with new trim frames made of wood or StarBoard.

Remove the frames carefully so at least one will be intact for use as a template. Naturally, if you plan to paint and reuse them, all must remain intact. Either way, clean the frame to remove all caulking, paint drips and accumulated dirt. If your boat has a wooden cabin trunk, as ours does, make new port frames of teak or mahogany. We chose mahogany to complement the existing wood.

Where the new frames are the same size as the old ones, simply use the original plastic frame as a pattern. If you want a slightly larger frame, as we did to cover the shadow left by the old frames on the cabin side, you'll need to make a new pattern.

Making a pattern is easy. Mill the mahogany to 9mm (3/8") thick; any thinner and it might crack. Screw the original frame onto the wrong side of the new wood, but not through the wood. Use two screws placed in diagonal corners and screwed in just far enough to hold the frame in place. Using a pencil, trace the inside cutout; then use a scribe set to the wider dimension and draw the outer shape. Remove the plastic frame from the wood. Rough cut the inside using a jigsaw (or bandsaw), cutting about 3mm (1/8") or so beyond the traced line. Cut the outside shape too, but cut this on the line. Sand the outside to a smooth, finished edge. Replace the plastic rim over the new wood. This serves as an accurate guide as you use the router to finish cutting the inner shape. This is your new template.



With the new template finished, you are ready to cut the actual port frames. Whether your pattern is the original plastic frame or a new template, be careful to remove all nicks, burrs, caulking etc. Any irregularity is replicated on the finished frames. Trace inside and outside lines on your wood, then rough cut each frame. Use double-sided tape to securely "clamp" the template (or plastic frame) to each new wood frame. This serves as an accurate guide to finish cut the shape using a router and 12mm (1/2") double-fluted tracer bit. Switch to a 6mm (1/4") corner-rounding bit to round the outside edges. Sand and varnish to match the cabin trunk or the boat's exterior wood trim pieces.

A traditional installation uses the original port frames as a guide for the number and placement of screws. Drill the screw holes, countersink the screw heads and use an appropriate wood-to-fiberglass or wood-to-wood caulking, such as 3M 4200. It's possible to epoxy wooden frames in place, rather than use screws. Use these same procedures to manufacture these frames of Starboard. They also could be made of aluminum, but it might be a project better left to a local metal fabricator. Aluminum frames are powder-coated, or primed and spray-painted with an appropriate coating.

About the authors: David and Zora Aiken are the authors and illustrators of numerous boating, camping and children's books, including "Good Boatkeeping" and "Good Cruising" published by International Marine.