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Tools & Gear

We Test So You Don't Have To

FishNLight

FishNLight

8

Underwater lights are cool, but adding through-hulls sometimes is not. That's why we like the Fish-N-Light ($219), which offers plenty of illumination without any holes.

The FishNLight is a portable droplight that connects to your AC or DC system (versions for each are available). You simply toss it over the side, tie it off and plug it in.

We tested a FishNLight BL100 from the Chesapeake Bay to Magdalena Bay and found it to be a great add-on solution. It comes standard with 25 feet of cable—more is available—and uses bulbs that can be purchased anywhere. It can operate in or out of water.

Because many bolts secure the watertight chamber, changing the bulb can be a chore. And the carrying bag offers the unit little protection; you might want to buy a hard case. But it never failed to frenzy the fish. **– Glen Justice**

PROS: Strong underwater light, without drilling holes in the boat.
CONS: Changing the bulb can be a task.

www.fishnlight.com

DIY Rating System

10. *Everyone should own this*
9. *A very strong product*
8. *Strong, with a note or two*
7. *A fine product*
6. *Good for some applications*
5. *Think about it first*
4. *We don't recommend it*
3. *Product has major flaws*
2. *Don't buy this*
1. *Don't even look at it*

Tools & Gear

ATN Topclimber

Bosun's chairs usually require two people: one to sit in the chair and one to crank the winch. The ATN Topclimber ($430) allows you to make that climb by yourself.

Using an adaptation of mountain climbing gear, a dedicated static line is run through locking devices attached to the Topclimber's seat and leg harnesses. One end of the line is then attached to a deck fitting. Using a halyard to raise the other end of the static line to the masthead, the line is made tight. You use the locking devices to climb the static line, first by standing in the leg harness and raising the seat, then sitting and raising the leg harness.

6

We used one to take a run up the mast, and we learned a few things. The climb can be slow. Moving the harnesses more than a few inches at a time makes it difficult to operate, and there's a bit of a learning curve to do it correctly. Also, if the static line is not perfectly vertical, gravity has a tendency to pull you around so that your back is to the mast. Using a safety line around the mast itself minimizes this effect.

The seat harness includes a pouch, allowing you to take tools and parts up with you. The arrangement of the harnesses allows you to stand above the masthead, useful for changing lights or antennas.

Topclimber

A standard bosun's chair is more useful if you need to move around the mast, to inspect spreader tips, for example. However, if you don't have a spare crew member or two to assist you, the Topclimber is one of the few ways to get to the masthead solo.

– Frank Mummert

PROS: Allows you to go aloft without help. Very stable.
CONS: Climbing is awkward.

www.atninc.com/topclimber.html

Ryobi 18-volt Corner Cat

6

Purchased as part of a Ryobi Combo Pack, and tried as a last resort when other sanders couldn't reach areas to be smoothed, the Ryobi 18-volt Corner Cat ($29.97, without battery) ended up becoming a favorite.

The Cat works well sanding up against teak trim and in corners where the only alternative is hand sanding. The hook and loop sanding pad makes changing sanding pads quick and easy, though the pads can be hard to find. There are also no accessories, like you find with competing sanders.

While the battery pack adds weight, it ends up being a well-balanced unit. Ryobi has just introduced lithium-ion battery packs to replace older nickel-cadmium ones. The new battery significantly extends sanding time and reduces recharging time.

Overall, the Cat gets the job done well.

– Paul Esterle

PROS: Inexpensive with strong battery life.
CONS: No additional accessories, and sanding pads can be hard to find.

www.RyobiTools.com

Paul Esterle

Paul Esterle

Shop-Vac 12-Gallon Wet-Dry Vacuum

The Shop-Vac 12-Gallon Wet-Dry Vacuum ($79) was purchased for use with a random orbital sander to control dust—and it works well.

8

The combination of a filter bag and filter canister means that fine sanding dust is kept out of the motor. The filter bag makes emptying the unit much cleaner than most—simply pull the bag out and dispose of the waste.

The unit is light enough to be easily hauled aboard for fall and spring cleaning. It does an excellent job as a wet vac, sucking the last traces of water out of the bilge. The built-in drain makes emptying liquids easy.

Its greatest feature is a low noise level (important when spending hours sanding). The wide, four-legged base with casters makes it stable yet easy to move around. The hose, which locks into the canister, is also a plus. **– Paul Esterle**

PROS: Quiet! Great filtration, stable and the hose locks in place.
CONS: Filter bags are sometimes hard to find.

www.Shopvac.com

Field Test

Picquic Screwdrivers

When I saw the Picquic in the aisle of my boating goods store, I had just one thought: more gimmicky multi-bit screwdrivers destined for the landfill. I wonder which developing economy produced these?

But I got a refreshing surprise: Picquic screwdrivers, available for about $20 and built in British Columbia, are well designed and well made, using quality materials. I have purchased several over the past two years, and I've got them all over the place: one in the kitchen, a few at the workbench, one in the car and the outstanding Picquic Mariner aboard the boat.

9

I like them so much that during a recent visit to Vancouver, I stopped by the factory and spoke with Kerry Martin, Picquic's sales and customer service guru. We discussed the company's 22-year history, the product's origins as a tool designed for small aircraft, the company's lifetime warranty and competition from cheaply made overseas knockoffs.

All Picquic screwdrivers feature the through-the-handle instant bit change system: To change bits, you take the current bit out of the shaft and push it into the bottom of the handle, behind the new bit you want. Storing the old bit and extracting the new bit occur simultaneously, so it's very difficult to misplace a bit. Grab the new bit, insert it into the magnetic bit-holder shaft, and you're ready to go. The bits are power-rated, so you can use them with your drill or power screwdriver, too.

The Picquic Mariner has been the "go-to" screwdriver aboard my boat for two cruising seasons, and I couldn't be happier. One note: on my boat, the Canadian version of the Mariner, which gives up some of the less-common sizes of conventional bits to include three sizes of square-drive bits, works out just a little bit better than the U.S. version. My boat uses at least two sizes of those square-drive bits. If you get a Mariner, consider tracking down the Canadian version if it better suits your needs.

– Tim Flanagan

www.picquic.com/bro-english.html

Picquic


Glen Justice

Ecolight Solar Flashlight

Flashlights are something all boaters struggle with. You misplace them. The batteries die. It's always something.

7

So the Ecolight ($39.95), a hand-held LED light that operates on solar power, promised some relief. The green plastic body, deceptively light, carries solar panels. Energy is stored in supercapacitors inside the unit, unlike most solar-powered tools, which store energy in a battery of some kind.

To charge, you simply leave it in the sun, or plug it into an AC or DC outlet. Interestingly, the unit can also be charged from a laptop or computer with a USB cable (a USB/DC charger is available for $3.95.).

We tested the EcoLight for several months and found it to be a fine specimen. It charged in the sun as promised, and it held that charge and function reliably. The beam is not the strongest, even on high. And you can buy a larger light for this price. But it is environmentally friendly, requires no batteries, floats, is water-resistant (not watertight) and generally gets the job done.

If you are looking to experiment with solar toys, this would be a good place to start. **– Glen Justice**

PROS: No batteries and no charging cables required.
CONS: You have to remember to charge it in the sun.

www.solareyinc.com

SmartPlug Shore Power System

SmartPlug is a shore power system designed to replace the standard twist-and-lock connector on dockside power cables that is standard today.

8

SmartPlug (about $225) offers an entire line of marine electrical connectors, including cordsets, adapters, and dockside and boatside receptacles. The line was launched last year with a 30-amp upgrade kit. A 50-amp version should be released sometime in 2010. The upgrade kit includes a boatside inlet and a plug you can install on your current shore power cord.

We found SmartPlug intuitive to use and reasonably easy to install, providing greater protection against loose connections and corrosion—the leading causes of shore power failure and fires.

With the 30-amp upgrade kit, you can use SmartPlug on the boat end of the power cord and keep the conventional twist-lock plug on the dockside end. That means you can protect your boat now, even if your marina hasn't yet upgraded. Secondary benefits include ease of use, both for crew members unfamiliar with the tricky twist-lock fittings and for the skipper in the dark.

– Tim Flanagan


Tim Flanagan

PROS: High-quality components in a kit that is relatively easy to install.
CONS: Cost—it is not cheap.
www.smartplug.com

Power Play

Add a Second Alternator to Give Your Electrical System a Boost

By Nigel Calder

It seems like you can never have enough power on modern boats.

Above a certain boat size, these power demands are typically accommodated by adding an AC generator, but for many of us this is not a practicable alternative. The answer, in this case, lies in adding a high-output alternator to the propulsion engine. I've done it on every boat I've owned for the past 25 years.

Engines

An alternator upgrade can dramatically increase the power available on most boats, at considerably less than the cost of installing a stand-alone generator. Adding a second alternator allows you to customize its performance and voltage regulation specifically for your power needs and the way you use your boat—and in a manner that you simply can't achieve with a single alternator.

However, such an upgrade needs to be made within the context of a review of the overall power needs and energy supply systems on the boat, and not as a stand-alone project. For example, once a new alternator is up and running, you may find that your batteries have a limited capacity to absorb all the power coming from that alternator, causing it to operate at a reduced output much of the time. If you are battery charging at anchor, this unnecessarily prolongs engine-running hours.

Nigel Calder is the author of the best-selling Boatowner's Mechanical and Electrical Manual *and* Marine Diesel Engines.

Nigel Calder

A second alternator is a cost-effective way to increase power.

You have to think through the entire system.

SPACE AND LOAD

When it comes to alternators, there are a couple of things to consider upfront. First, is there enough space in the engine compartment? Normally, the second alternator mounts to the side of the engine opposite the existing alternator, but sometimes it just won't fit, given the need to allow some room for belt tensioning.

On one of my boats I placed the alternator in front of the engine, facing "backwards" so that the pulley was in line with the crankshaft pulley. Installed like this, it effectively fit under the bottom rung of the companionway ladder. However, this required expensive custom-made brackets, as opposed to the off-the-shelf kits available for many side-mount installations. You also need a bidirectional alternator (one in which the fan works in either direction), because the alternator will, in effect, be running backwards.

The second issue is the load the alternator will place on the engine. Let's do a little math. One horsepower equals 756 watts. Let's assume a nominal 100-amp, 12-volt alternator. The charging voltage will be around 14.0 volts, so at 100 amps the alternator is putting out around 1,400 watts. In theory, it will take about 2 horsepower to drive it. In practice, however, it is unlikely to be more than 50 percent efficient, and there are also belt losses. In reality, it's going to take 4 horsepower or more to drive it.

I've installed alternators with outputs as high as 200 amps at 24 volts that can place loads as high as 15 to 20 horsepower on the engine. Depending on the size of the engine, this can have a significant impact on the power available for propulsion and can place a substantial side load on the crankshaft pulley and any other pulleys included in the belt circuit (there's often a water pump).

The best guide to what is practicable is to look at what has already been done with your engine. For most popular marine engines, add-on alternator kits are now available, either from the engine manufacturer or from specialist suppliers such as Balmar or Ample Technologies.

You should try to avoid a custom installation. It is expensive, and it's not always easy to get the brackets right in terms of belt alignment. Mistakes here can chew up belts, and there's a risk of bracket failure from harmonic vibrations that will fracture even custom brackets that seem heavily built.

Sometimes, there is just not enough room to add a second alternator. In this case, it is often desirable to take off the alternator that came with the engine and replace it with an externally regulated, high-output alternator. Unfortunately, this is not quite as simple as it sounds.

First, you may need new brackets. Second, you cannot use the existing wiring harness. Above all, you will need to upgrade the size of the alternator output cable (see below). You will also likely want to run the output cable to a different point in your DC system, but this gets us into a discussion on how to optimize DC systems, which is well beyond our scope here. Finally, if you play with the pulley sizes to increase the alternator output (once again, see below), and if the tachometer on your boat reads speed from the alternator output, the tachometer will read incorrectly!

TECHNICAL CONSIDERATIONS

Assuming we've found a place to fit the alternator, it's time to think about construction and performance issues.

photos by Nigel Calder

Above: Anything larger than a 100-amp, 12-volt alternator generally requires two belts.

Left: Improper installation can wear out belts.

You are going to work your new alternator hard, so you should get one that is rated for full continuous output. This requires a high temperature (200 degrees Fahrenheit) or "KKK" rating.

Most alternators are built for automotive use. Cruising down the highway, a car engine will be doing better than 2,000 RPM. An alternator generally has a 2-to-1 pulley ratio, which means the alternator is now running at 4,000 or more RPM. Typically, they are designed to reach full output at about 5,000 RPM.

In contrast, most boat engines spend much of their time at lower engine speeds than cars, especially when they are charging a battery at anchor. The output of an automotive-style alternator can drop rapidly to where it is not much use. Therefore—and this is important—we need alternators that are designed to reach full output at relatively slow speeds. This requires a different internal construction. The way to check is to obtain the output curve (amps versus rpm) for the alternator. I've seen 200-amp alternators that had a lower output at typical boat engine operating speeds than competing 160-amp alternators.

You can always increase the speed of an alternator by increasing the size of the pulley on the engine, but this generally requires some degree of customization. Another way to go is to reduce the pulley size on the alternator, but this substantially increases belt stress and the risk of slippage. A slipping belt will destroy not only the belt but also the alternator if it continues for any length of time (the heat generated demagnetizes the rotor).

As noted above, belt loads can be high. My experience with the conventional V-belts found on older engines has been that a single ½-inch belt, properly tensioned, is good for a 100-amp, 12-volt alternator. Above this, it is necessary to go to two belts. I have had excellent results with Gates Green Stripe belts and lousy experiences with a number of others. Modern engines tend to have high-tech serpentine belts, which can tolerate enormous loads.

If possible, you should include a belt

tensioner in the circuit. It makes life a lot easier than using a large screwdriver or something similar, such as a lever.

Make sure you follow the ABYC standards when refitting the electrical connections and purchase materials from a marine chandlery, not an automotive or household electrical store.

HOW BIG AN ALTERNATOR?

There's a limit to how much alternator output any electrical system can accept. Note that if you oversize the alternator, it won't do any harm—you will simply have paid for more capacity than you can use. So how big should it be?

The basic rule of thumb is as follows: the alternator's hot-rated output (the KKK rating) at the speeds you will be using should ideally be at least 25 percent of the total capacity of any wet-cell batteries it is charging, 35 percent of gel cells, 40 percent of AGMs and 50 percent of the new Thin Plate Pure Lead (TPPL) batteries. If you can afford exotic batteries such as lithium-ion, you can try to achieve 100 percent, but you likely won't be able to find an alternator that powerful that fits in your boat and that your engine can handle.

ELECTRICAL INSTALLATION

The standard alternator output cable found on engines is nowhere near large enough to handle a high-output alternator. It will cause excessive voltage drop and may start a fire. You are going to need a large cable from the back of the alternator to the point of connection with the DC system. The longer the cable run, the larger the cable. At 100 amps or more (for both 12 and 24 volts) you should be looking at 1/0 and 2/0 cables, the latter being as big around as your thumb. You should consult the American Boat and Yacht Council tables using the 3 percent volt drop table, found on the ABYC Web site or in my book, *Boatowner's Mechanical and Electrical Manual*.

You will then need a fuse at the point of connection between the positive cable and the boat's DC system. This fuse needs to be rated at no more than 130 percent of the amp rating (the ampacity) of the cable you are using. It should also be at least 150 percent higher than the rated output of the alternator. This minimizes the risk of nuisance blowing, which, if it should happen, is likely to destroy your expensive alternator. If necessary, increase the cable size to get a higher ampacity rating, so that you can get the fuse rating above 150 percent of the alternator's output. Use a slow-blow fuse to further reduce the chance of nuisance blowing.

Your cables should come from a marine chandlery and not an automotive or household electrical store. You want tin-plated, stranded cable that is labeled "Boat Cable" and/or "UL1426." The price will make you flinch! Your terminals should also be bought at a marine chandlery, where they sell tin-plated copper, as opposed to the nickel-plated steel often found at automotive stores. Finally, you will need specialized tools, notably, a cable crimper capable of putting terminals on the large cables. It is a good idea to seal all terminals with heat-shrink tubing.

Most high-output alternators have an external, multi-step voltage regulator. This is recommended over an internal regulator because it gives you a lot more set-up and fine-tuning options. However, it requires quite a bit of wiring. There are excellent manuals that come with these regulators, but a first-time installer might want backup from someone with experience.

As you can see, this stuff is a bit technical. It's important to get it right. If in doubt, consult a certified marine electrician. Note also that it can take a couple of days to do an installation—especially the first time around. **DIY**

Departments

Night Vision

Red LEDs Offer Interior Light at Night

By Harry Hungate

photos and graphic by Harry Hungate

Your existing fixtures can be augmented with red LEDs to accommodate night vision.

Electrical

Several overnight passages on *Cormorant*, our Corbin 39 cutter, convinced us that we needed full-time interior night lighting for both safety and convenience. Our aims were to preserve night vision and to keep our power consumption as low as possible. Cost and long-life were also considerations.

Our vessel already had several ceiling fixtures using standard 12-volt incandescent bulbs, so we developed a low-cost and relatively easy way to add night lighting using red LEDs (light-emitting diodes). Each LED light fixture consumes a miserly 20 milliamps—that's 0.02 of an amp—and their life is measured in tens of thousands of hours.

A separate switch for the LEDs eliminates the problem of remembering which way to toggle a fixture on or off—and eliminates the danger of ruining night vision when you guess wrong. A bonus feature was the ability to adjust the LED lighting levels. But usually, we simply turn on the LEDs at dusk and turn them off at dawn when on passage.

The installation job requires modest soldering skills, a few hand tools and a measure of patience. As far as materials, you will need eight red LEDs (5 millimeter and 1,000 MCD); one linear potentiometer (2,000 ohms and 250 milliwatts) with an on-off switch and a knob; one roll of rosin core electronic solder; one tube of clear marine silicone rubber; two feet of 1/16-inch heat shrink insulation; one foot of tinned hookup wire (18 or 20 AWG); and some metal polish.

Harry Hungate and his wife, Jane, have lived aboard Cormorant, *their Corbin 39, since 1997 and have sailed over 40,000 miles. Both are Extra Class hams and ARRL volunteer examiners. Harry holds the FCC GROL with radar endorsement license and in his spare time tinkers with electronics.*

GETTING STARTED

First, make sure that the power is off, and then remove your light fixture. Disconnect the two power leads one at a time, carefully taping each lead to prevent a short circuit. Turn the power back on and use your voltmeter to identify the positive and negative leads and label them, as well as the leads on the fixture itself. Turn the power off again.

I recommend using blade-and-socket crimp-on terminals to connect your light fixtures. Put the socket terminal on the positive supply lead, and the blade terminal on the negative supply lead. This will ensure that when reconnecting the fixture, polarity will always be correct.

Remove the glass or plastic lens and incandescent bulb. Drill a hole in the side of the fixture, near the on-off switch, to mount the linear potentiometer you will use if you want to be able to dim the LEDs. Polish the reflector carefully.

What You Will Need

- Eight red LEDs: 5 millimeter diameter and 1,000 MCD
- One linear potentiometer: 2,000 ohms and 250 milliwatts, with on-off switch and knob
- One roll of rosin core electronic solder (do not use acid core solder)
- One soldering pen, iron or gun
- One tube of clear marine silicone rubber
- Two feet of 1/16 inch heat shrink insulation
- One foot of tinned hookup wire (18 or 20 AWG)
- Metal polish
- Screwdriver
- Pliers
- Wire stripper or knife
- Digital multi-meter or analog meter that will measure volts and ohms
- One roll of vinyl electrical tape
- Drill and drill bits

Take a close look at one of your newly acquired LEDs: You will notice that one lead is slightly longer than the other. The longest lead is the anode, or positive lead, and the shorter lead is the cathode, or negative lead. The lens will have a flat spot at the negative lead. Pay close attention to the anodes and cathodes as the LEDs are polarity sensitive, allowing electricity to flow in only one direction.

Your LEDs will come with a data sheet showing the working voltage and current consumption. The working voltage is called forward voltage (abbreviated Vf) and is typically about 1.7 volts DC. The current consumption is usually 20 milliamps. Your vessel's electrical system is theoretically 12 volts DC, but in actual practice it's closer to 12.6 volts DC. LEDs are generally wired in a series to use all of the available voltage, as overdriving them will greatly shorten their lives.

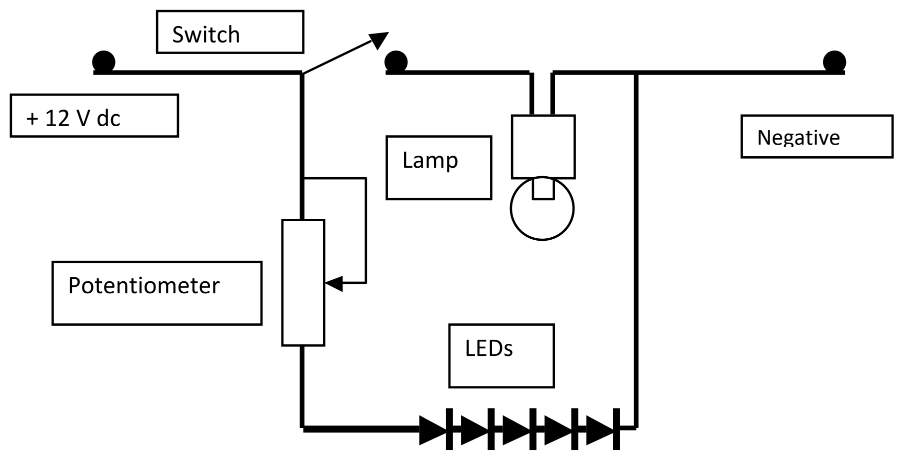
To do this, first determine the required number of LEDs by dividing 12.6 volts (your vessel's supply voltage) by 1.7 volts (the LED forward voltage). In this case, you get 7.4—which can be rounded to 7 LEDs—though you may get different numbers if your vessel's voltage or your LED forward voltage is different.

MAKING CONNECTIONS

Prepare 7 LEDs by bending the leads. Cut the heat-shrink insulation into 14 lengths just long enough to cover the LED leads with about ⅛ inch of lead protruding. Slip the lengths of heat shrink insulation over each LED lead and shrink the tubing. Arrange the LEDs in a circle in the light fixture and fix them in place with a dab of silicon. Set the fixture aside while it cures.

There are three terminals on your potentiometer: high, wiper and low. Use your ohm meter to identify which terminals on the potentiometer yield decreasing resistance when the shaft is turned clockwise. It will be either high to wiper or low to wiper. This is key if you want more light when the knob is turned clockwise. Install the potentiometer in the fixture so that the terminals are accessible.

After the silicon has cured on the LEDs, solder the leads together: the anode of one LED to the cathode of its neighbor. Solder a short length of hookup wire (about 4 inches) to the end of each of the two remaining LED leads. Solder the positive hookup wire from the LEDs to the high and wiper terminals on the potentiometer. Solder one end of a short length of hookup wire to the remaining potentiometer terminal (high or low as determined) and solder the other end of this hookup wire to the positive power lead on the light fixture. Solder the negative hookup wire from the LEDs to the negative power lead on the light fixture.



Schematic of Combined Incandescent and LED Lights

Bending LED leads to adjust light pattern and to lift LED leads clear of reflector.

Reassemble the incandescent bulb and lens. Reconnect the power leads, carefully turn on the power and switch on the incandescent lamp to make sure it still works. If not, it's time to correct the problem.

To troubleshoot, check for voltage at the potentiometer with your voltmeter. With the LEDs switched off, one terminal should measure 12 volts or more to ground (the fixture negative lead), and the other terminal should read zero volts to ground. If no voltage is present, check the connections for mistakes or poor solder joints.

Now slowly turn the potentiometer clockwise. The voltage from wiper to ground should increase. If it doesn't, find and correct the problem. Now check the voltage to ground from each LED around the circle. The voltage should decrease by 1.7 volts or so at each LED. A bad LED will either be shorted (no voltage drop) or open (no voltage at the following LED). If a bad LED is found, remove it and replace it with a spare (now you know why you bought an extra LED or two).

Which brings us to cost. The materials for the project ran a total of $10, and the whole job took less than two hours to complete.

Job done, you are now familiar with augmenting light fixtures and can easily convert your remaining lights. **DIY**

Touchy Feely

Should a Touch-Screen Plotter Be at Your Helm?

By Lenny Rudow

Electronics

Most of us in modern society interface with the world with our fingers: Text messages, e-mails and instant messages have surpassed voice communications in a thousand different ways. So it's only natural that touch screens have become all the rage in electronics of many different forms—including on your boat.

Get your hands on the latest touch screens on the market, and you'll discover awesome interfaces that seem to flow like a river—until they don't. Yes, there are problems with getting all touchy-feely on a boat, problems that don't normally arise when you let your fingers do the walking on dry land.

This is no surprise, because nearly every format of new marine technology follows land-based developments—and then encounters its own set of problems when taken to sea. So, should there really be a touch screen at your helm? Yes. No. Maybe.

FEELIN' GOOD

If you've ever withdrawn cash from an ATM, you're already familiar with touch screen interface.

When you put your pointer on any of the current marine touch screen displays, you'll quickly discover that they're every bit as intuitive as those developed for land-based applications, which must serve both man and moron. That means you can spend less time figuring out how to use your electronics and more time fishing, cruising or whatever you enjoy doing on the water.

Simple functions like zooming your chartplotter in and out are a perfect example. If you want to go from a five-mile view to a half-mile view on a keyed unit, press the zoom key five or six times in quick succession. Then you'll wait for the unit's processor to catch up to your warp-speed button-pressing. When it displays the new zoom level, you may not see the right view. Now you'll have to re-center the cursor on the screen and restart the process. While occupied with the unit, you might not have noticed that log bobbing around dead ahead. Or maybe you drifted five or six degrees off course. You get the picture.

So, what would this have been like with a touch screen? You could have placed your pinched fingers on the unit, and spread them wide to zoom in on the specific area of the chart that interested you. Re-centering is automatic, and the width of your fingers determines the zoom level. The entire operation takes a lot less time.

Added bonus: Ease of use and faster functionality mean that you'll be able to decode and use more of the complex functions your unit offers—functions that that you might never have figured out or simply wouldn't have bothered to use, like accessing port services information or calculating complex routes.

FINGER PLAY

So if touch screens have revolutionized interfaces from fast food to cell phones, why don't we see them on every boat?

The first and biggest factor is also the most obvious: Boats move, constantly. And when a rough sea adventure has you clinging to the pipework, it gets substantially harder to use a touch screen to navigate. Put your fingers anywhere near that screen and you could end up setting a waypoint for Burundi instead of Bermuda. This is one time when buttons shine—operators can rest their hand on the dash or the corner of the unit, and aim their thumb during those short moments of hang-time stability between crashing waves.

Early marine units, like Maptech's i3, failed to address this issue and, as a result, they quickly went extinct. Fortunately, this problem can be solved by simply adding a basic keypad to touch screen units, and most manufacturers are trending in this direction. Check out the latest hard-mounted units to hit the market, like Raymarine's E-series Widescreen with hybridTouch, or in hand-held navigation, such as Lowrance's Endura series, and you'll notice that they incorporate keypads as well as the touch screen interface.

The second problem with getting all

Lenny Rudow was senior technical editor for Boating *magazine for more than 10 years, and is currently the electronics editor for* Marlin *and* GoBoating *magazines.*

touchy-feely on boats is cleanliness. What with salt spray, greasy fittings and flying fish scales, a boat can be a pretty dirty place, and touch screens don't like dirt. Most won't function properly if they get too cruddy, and some may even be damaged if you grind a dirty finger across the face of the unit with a little too much vigor. Again, early units didn't address this issue sufficiently, but some of the newest ones do.

Manufacturers claim that hardened, etched-glass screen surfaces are essentially scratch-free, and infrared screen capabilities do a good job of reading through a haze. When testing Northstar's 8000i, for example, I was able to use the touch screen when covering it with a piece of paper, a shirt sleeve and even a healthy dollop of Famous Dave's Bar-B-Q sauce. (Sorry, Northstar, but a tester's gotta do what a tester's gotta do.)

So if you choose a touch screen unit, make darn sure it has those two key attributes: backup buttons and a dirt-safe infrared screen. **DIY**

all photos courtesy of the manufacturers

Which Chartplotters Are Easiest to Use? We Tested.

Is the chartplotter on your dash easy to use? Your response may have as much to do with how you process information as the manufacturer's specs. Some units will match your sense of order, while others will leave you scratching your head.

Manufacturer	Left Brain Dominant Average Time (sec.)	Right Brain Dominant Average Time (sec.)	Total Average Time (sec.)
Garmin	107	84	96
Interphase	119	102	116
Lowrance	90	76	83
Raymarine	146	138	142
Standard Horizon	133	118	126

To find out more, we mounted five different chartplotters side by side and timed 15 boaters as they tried to figure out how to use each one. Then our test subjects subjected themselves to a test about how they process information—the whole "left brain, right brain" argument—and we matched up the results.

What emerged are some useful insights into how people use equipment, including some hints at why features like a touch screen or programmable "soft keys" may or may not be a match for you.

Here are the results, calibrated in seconds. To read more about our test, including what we asked participants to do, visit www.madmariner.com/test.

– Lenny Rudow

Touchscreen Options

By Lenny Rudow

So what are your options when shopping for a touch-screen unit? Here's a rundown:

FARIA MAESTRO, www.faria.com. More than a chartplotter touch-screen interface, the Maestro is closer to a glass bridge system that fits into the helm of vessels that are more accurately categorized as boats than yachts. It includes a computer with a sealed CPU, the (15-inch, 12.1-inch or 8.4-inch) TFT touch screen (which utilizes Maptech's easy-to-use software interface) preloaded 2-D/3-D cartography, photo and topographic maps, network radar and autopilot expandability, fish finder, weather reporting and camera input capabilities. The system even comes with Wi-Fi. But there's one big downside: It doesn't have backup keys, so navigation in rough waters could be challenging. Units are essentially custom built so pricing starts at several thousand dollars.

GARMIN'S 5000 SERIES, www.garmin.com. The 5000 series ranges from 8.4-inch, 640-by-480 pixel, to a 15-inch, 1024-by-768 pixel VGA touch-screen display. It's fully network-capable via NMEA 2000, NMEA 0183 or Garmin's Marine Network. Like

Departments

most Garmin units, the menu and software are surprisingly easy to use, and it ranks among the simplest to figure out in marine electronics. Cartography includes 3-D mapping capabilities, built-in worldwide base maps and satellite imagery, and BlueChart g2 Vision expandability. So, what's not to love? On its Web site, Garmin says, "This flagship marine navigator is missing just one thing—buttons." Truer words have never been spoken. $2,899 to $6,099.

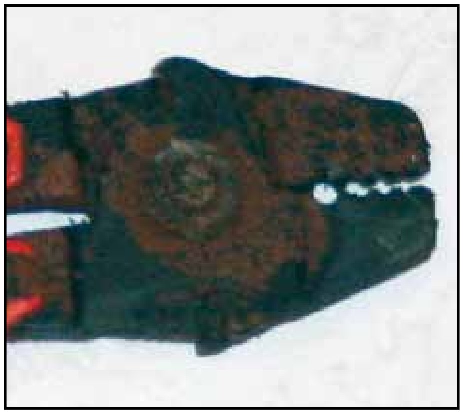
GARMIN GPSMAP 640, www.garmin.com. This combines marine and land applications in a unit that can be portable or fixed. It has a 5.2-inch, WVGA 800–by-400 pixel touch screen and sits in your hand or lap like a small notebook while running on rechargeable lithium-ion battery pack power when not plugged in. I tried driving with the 640 sitting on the car seat next to me and on the dash, and wherever I put it, the integrated antenna held its fix without a glitch. Clip on the marine or automotive mount, plug it into a 12-V outlet, and it acts like a fixed-mount unit. There are separate automotive and marine modes, which help make the shift from land to sea easy. On the marine side, you get BlueChart g2 data including depth contours, nav aids, port info, and tides and currents. I like that it's waterproof to IPX7 standards, but I don't like the lack of a backup keypad. Still, it's worth considering if you want a unit for use in both cars and boats, with more emphasis on the land-based application. $1,199.

LOWRANCE'S ENDURA SERIES, www.lowrance.com. The Outback, Safari and Sierra lineup of hand-held GPS units are designed for the marine world (and are waterproof to IPX7 standards, so they can take a 30-minute dunking under a meter of water) with touch-screen interfaces that are backed up by an integrated keypad. When I got my hands on test units, I discovered intuitive menus and fast screen re-draws. Cartography comes courtesy of Navionics, and the inclusion of Navtec road mapping means the Enduras will come in handy in the car as well as on the boat. You have to sacrifice a bit of screen size to get that keypad on the compact hand-held footprint, but it's well worth it. $229 to $550.

NORTHSTAR'S 8000I, www.northstarnav.com. This fully networked NMEA 0183 unit is one of the oldest marine touch screens around, having been available for several years. The system offers 12-inch and 15-inch SVGA displays with an infrared interface and a full backup keypad, and it can also be controlled via an added USB pointer, keypad, mouse or trackball. The system is expandable with radar, depth sounder, video and network camera monitoring, DVD/CD/MP3 players, instrument repeaters and a fuel/engine management system. It's waterproof to IPX6 standards and has cartography that's C-Map expandable. This is another unit that was very intuitive to use; I rarely needed to refer to the instruction manual. $4,500 to $6,500.

RAYMARINE E-SERIES WIDESCREEN HYBRID-TOUCH, www.raymarine.com. The hybridTouch is one of the newest touch-screen interfaces available in marine electronics. The 9-inch display has 800-by-480 pixels, on a sunlight-viewable TFT LCD screen (12.1-inch and 14.1-inch displays are also available). These units are waterproof to IPX6 standards, are fully networkable and come preloaded with an assortment of charts. Because it's so new, I have yet to have a hands-on, on-the-water experience with it, but it boasts several new features that seem promising. The smart phone-style menu system is new, for example, and the radar has a digital bird-tracking mode to optimize returns from sea birds. And yes, there's a fully functional keypad interface that keeps you on target when the seas kick up. $3,995 to $6,495.

BEFORE



AFTER 12 HOURS

FINAL

Lenny Rudow

Bust Rust

Build Your Own Electrolysis Bath and Beat Back Corrosion

By Lenny Rudow

EDITOR'S NOTE: *Anytime we work with electricity, there is risk involved, just as there is when we work with a saw or grinder. Be sure to take proper precautions on this project, such as working in a ventilated area, keeping the charger unplugged until ready and taking care not to touch the electrolyte bath or the items in it when the charger is plugged in. Read the safety notes before you begin.*

WARNING

Electrical current faults can cause serious personal injury or death. Disconnect battery charger from its energy source whenever working with water or other aqueous liquids used in this project.

To avoid serious injury or death from explosion, fire or electrical shock while working with any level of electrical current voltage, disconnect the power source before touching any connections.

Exposure to an electrolytic bath can cause serious personal injury or death from electrical shock, chemical splash and/or chemical reaction vapors. Some of these exposures include electrical current, toxic chromium compounds and toxic hydrogen gas vapors.

To avoid serious injury or death from fire, explosion, electrical shock or chemical exposures, always work in a well-ventilated area with positive ventilation means, e.g., a fan or blower, to prevent vapors from concentrating in an enclosed space.

Always wear protective clothing, e.g., gloves, apron, facemask, eye protection or other appropriate garments or shields to avoid the hazards of chemical splash.

Never touch the electrolytic bath when the battery charger is energized. Always observe the battery charger manufacturer's cautions and recommendations for its use.

DIY is so serious about safety, we created our own warning label, using ABYC standards of course.

Maintenance

They say that death and taxes are the only two sure things in life, but we boaters know there's a third—corrosion. If you own a boat, you've experienced the effects of the corrosive marine environment. Sure, we try to get hardware that's 316-grade stainless steel, buy high-quality tools and use only stainless fittings. But no matter who you are or what you ride on, corrosion is sure to get you sooner or later.

Most of us deal with corrosion by attempting to take preventive measures. We coat metals with inhibitors, rinse everything aboard with fresh water and clean corrosion as soon as it appears. But if this scourge takes a foothold, it usually means resorting to the wire brush treatment—and that's no fun.

Scrubbing metal with a wire brush (with bristles of nonferrous metals like stainless steel or bronze, which won't leave particles around to rust and aggravate the problem) inevitably makes a huge mess. And when you're finished, it's rare to have removed 100 percent of the corrosion. DIY boaters know exactly what I'm talking about, because you've been there and done that.

But here's a news flash: You can kick corrosion off of any ferrous metal fitting or tool with a minimum amount of work and time, and without that messy wire brush.

GO ELECTRIC

Electrolysis is the secret weapon you need to clean up that metal without manual scrubbing. Before we get started on the "how," let's make sure everyone understands the "why."

In a nutshell, the formation of red corrosion on metal—rust—is an electrochemical process called oxidation. During oxidation, the metal loses electrons, which then combine with oxygen molecules to create a substance called ferrous oxide, that crusty red stuff we love to hate.

But it is possible to reverse this reaction with a process known as electrolysis (sometimes also called electrolytic cleaning, or oxidation reduction). This process essentially removes corrosion from a metal surface by subjecting it to an electric current in an electrolytic bath. Although we boaters don't commonly perform electrolysis, it's a very simple process that's regularly used by archaeologists to repair and conserve metal artifacts.

Why don't boaters commonly use electrolysis? Probably because it seems like a dangerous endeavor. Mixing electricity and water can be scary—and it should be. But in this case, the risk is very low. Obviously, you still need to be careful and use the proper gear and precautions. You should undertake this project only if you have experience with basic household electrical work, and be sure to read all of the safety notes before you try this.


Lenny Rudow

A basic electrolysis bath can remove rust in as little as 24 hours.

GETTING READY

Here's what you need to get started:

» A regulated low-voltage, low-amperage power supply. Regular one- or two-amp 12-volt car/boat battery chargers with alligator clips work well for this purpose. Make sure the charger is in good working order.

» An electrolyte. Sodium carbonate (washing soda) is the norm, and most powdered dishwasher detergents work as well, because they're composed mostly of sodium carbonate and sodium silicate. You'll mix this with water to create an electrolyte bath.

» An anode. The anode is going to be your sacrificial metal, and will be corroded and/or destroyed in the process, so don't use something of value. It can be a piece of sheet metal, a steel rod or just about any other piece of scrap metal that's not galvanized or plated. One item that works extremely well is a foot-long piece of rebar, which can be purchased for pennies at any hardware store.

SAFETY NOTE: Do not use stainless steel for your anode. Because stainless steel contains chromium, chromium compounds may be released during the electrolysis process. Chromium compounds are poisonous and can taint the water in your electrolysis bath or be released into the air.

» A cathode, which is the corroded item you're trying to clean up. For this article, I used a pair of old crimpers that were corroded beyond repair—or so it seemed.

» A large nonconductive container. Plastic tubs are perfect for this job.

When you're ready to begin, set up the electrolyte bath in your nonconductive tub by filling it with enough water to submerge the item you're trying to repair. Then, add one tablespoon of electrolyte for each gallon of water. Give it several minutes to dissolve, stirring as necessary.

SAFETY NOTE: Set up your electrolysis bath in a well-ventilated area. This process gives off a very small amount of hydrogen gas, which is highly explosive. Strong ventilation must be maintained at all times to prevent a buildup of hydrogen gases.

Be sure the charger is unplugged.

Next, prepare your cathode by scraping a small section of the metal clean. You'll need enough shiny metal visible to provide a clean attachment point for the battery charger's alligator clip. Once it's ready, attach the negative terminal of the battery charger (still unplugged) to the clean area.

SAFETY NOTE: Check, double check and triple check to make sure the battery charger is not plugged in whenever you are connecting and/or disconnecting anything to its terminals.

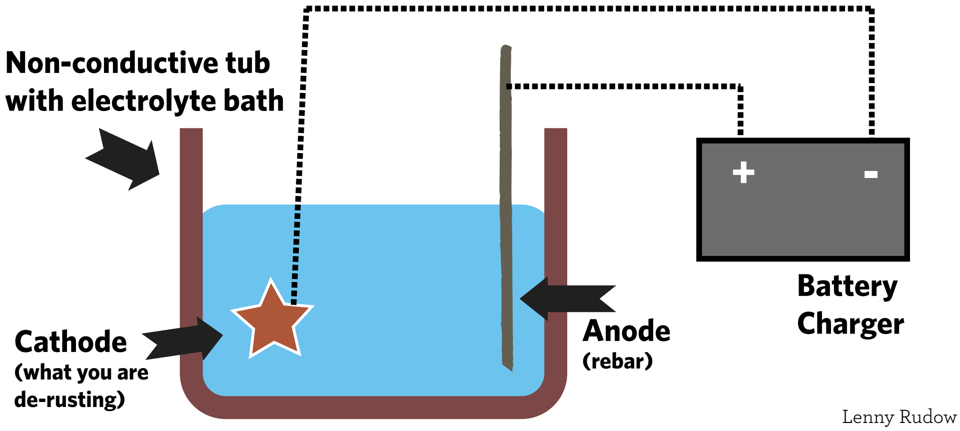
Remember—negative gets connected to the item you're cleaning up. The positive lead will be connected to the sacrificial anode. Hitch them up backwards, and you'll assure the destruction of whatever it is you're trying to save. Once it's hooked up properly, go ahead and submerge it in the electrolyte bath.

Next, clip the positive lead from the battery charger to your anode. Make sure that the anode projects above the water's surface and that the alligator clip from the battery charger stays out of the water. Otherwise, the clip will attract corrosion along with the anode and be ruined. This is one reason that rebar works so well. Because it is long and thin, it can easily be propped up in a corner of the tub.

Make sure that the anode and the cathode do not touch and that they are far enough apart that there's no chance they will contact each other.

GETTING STARTED

With the anode and cathode connected to the battery charger, the parts suffi-



Lenny Rudow

ciently separated and submerged in the electrolyte, and good ventilation ensured, you're ready to plug in that charger and get the electrolytic ball rolling.

Be sure never to touch any part of the electrolysis bath and/or parts while the battery charger is plugged in.

SAFETY NOTE: One of the reasons you use a battery charger for this process is to keep the voltage low, thereby minimizing risk. Still, any time you use electricity there's some amount of danger involved, so be sure to never touch any part of the electrolysis bath and/or parts while the charger is plugged in.

As you can see, in the photos on page 15, the crimpers I used as the cathode (the item I wanted to clean) were corroded well beyond a usable state. Yet after a mere 12 hours, there was an obvious difference in the amount of corrosion. It was definitely cleaner.

After 24 hours in the bath, the crimpers were amazingly clean. I removed them and found I could open and close them easily—the tool was fully functional again. In fact, I could clearly see the gauge ratings on each tooth, which had formerly been obliterated by the corrosion.

After unplugging the charger and removing the crimpers, I cleaned the tool off with a rag and gave it a thorough bath with CorrosionX, then broke down the electrolysis bath. When I looked at the submerged section of the rebar, it had clearly sucked up all the nasty stuff that had formerly coated my crimpers.

This low-labor method of cleaning up and restoring a formerly inoperative corroded metal item works extremely well. So the next time something on your boat falls victim to rust, set up an electrolysis bath. You can just win the battle against corrosion—it's as sure a bet as death, taxes and, well, you know. DIY

Varnishing Act

As Teak Becomes Scarce, New Products Hit the Market to Fill the Gap

By Roger Marshall

Technology

Talk to any yacht builder today, and you'll learn that good teak is both very scarce and very expensive.

"Due to extensive harvesting, old-growth teak is becoming extremely hard to get," said Peter Wormwood, customer service expert at Teak Decking Systems, a Florida company that supplies teak decking for yachts worldwide.

The boards coming from Asia, he said, are shorter and shorter. "We often see yacht specifications calling for 4- or 5-meter-long teak, but the fact is it just isn't available anymore," Wormwood said.

Old-growth teak remains in demand because it can stand up to the rigors of both weather and constant scrubbing. Plantation-grown teak, which is raised in direct sunlight, making it grow fast and much softer compared with old-growth wood, is less durable and therefore less appropriate for decks.

"The faster our business expands," Wormwood said, "the harder it is for us to get the teak we need to keep up. Plus the cost continues to rise."

UNDERSTANDING SCARCITY

Today's teak shortage started before World War II, when teak was harvested from the world's rain forests. Saplings were not planted to replenish the stocks. Although the government of Indonesia, a major producer of teak, acknowledged as far back as 1930 that old-growth teak was becoming depleted, little was done at the time about the problem.

Then, in 1975, the United Nations Food and Agriculture Organization published a paper outlining the extent of teak depletion worldwide, especially in Asia where the majority of teak is grown. By then the decline in teak availability and quality was becoming increasingly apparent to those who use the wood.

Many people wonder why teak forests can't simply be replanted to meet today's demand. But the solution isn't as simple as it may seem. One problem is that teak seedlings are traditionally hard to germinate, although tissue culture is reducing that stumbling block.

Another hurdle is that teak grows very slowly, especially in a forest environment. It can take as long as 90 years for teak to reach maturity—and that's a long wait. Teak is also fairly particular about its environment. It does best in temperatures between about 75 and 85 degrees Fahrenheit, with rainfalls of about 45 to 95 inches a year and soil that is deep and slightly acidic. It does not grow well in alkaline, heavy and compacted soils.

Another contributing factor to the current scarcity of old-growth teak is the United Nations embargo on supplies from Myanmar. The country formerly known as Burma has the growing conditions needed to produce some of the best teak in the world, and it still has large areas of old-growth teak forest. But because of the military junta that seized power there in 1988, exports from Myanmar have been banned by international agreement. As a result, yacht builders consider Myanmar teak off-limits as a source.

This is not to say that Myanmar teak doesn't reach world markets. It is suspected that some of the teak exported from India and Thailand actually comes from Myanmar and is illegally shipped to these neighboring countries in order to be sold. Because the Myanmar junta has done little to support the infrastructure needed to harvest teak, the trees there are typically cut into relatively short eight- to 10-foot logs that can be easily trucked or dragged out of the forest. Using normal modern-day harvesting methods, these same trees would be cut into logs of 20 feet or more, which could then provide lengths of lumber long enough for yacht decking.

Not all teak trees are suitable for boatbuilding, not even all those that grow in the forest. Lime or calcareous teak is inappropriate because it has a lighter color and may have lime concretions in the wood. Similarly, wrinkled or waxy teak may have rippled fibers that make it hard to manipulate for decking. And because of different soil types, teak from different parts of the world is not all of the same quality. Java teak, for example, often contains more lime than Myanmar or Thai teak. These variations exacerbate the problem of finding quality supplies for boatbuilding.

TEAK ALTERNATIVES

So what's a boat owner in search of teak to do?

There are several "glue-on" materials, such as Treadmaster M and PlasDeck, that give a secure, nonskid surface. Decks can also be coated with nonskid paint. But these solutions do not replicate the look of teak.

There are, however, several non-teak materials available that do give the look of a teak deck. Most of them have nonskid qualities, are relatively easy to install and last at least as long as traditional teak. They can also be easier to maintain.

The installation of many of these products varies according to the nature of the material. Some are installed the same way as teak planking, except that it is glued down rather than screwed. A caulking material is then poured between the planks. To finish the installation, the planks and

NuTeak

Esthec

Top, new and old compared of a NuTeak installation. **Above**, Esthec allows for totally unique patterns.

caulking are sanded back to produce an even finish. Another commonly used method is to make a template of the area to be covered and send it to the manufacturer, which makes the entire deck and ships it back. All you have to do is unroll it and glue it into place.

Flexiteek (www.flexiteek.com), for example, is a composite PVC-based material that looks and feels like teak. The owner provides a template for the job, and the company makes the deck. When it arrives, it is ready to glue into place on wood, fiberglass, aluminum or steel. Flexiteek can be lightly sanded to remove any stains and to refresh the surface. It is naturally colored and can be cleaned easily with soap and water.

Esthec (www.bolidt.nl/esthec) is another synthetic option, made in Holland. Unlike other decking systems, Esthec is available in 10 colors. It is durable, does not dry out like teak, resists fading, is far lighter than teak and wears equally as well. One of the big advantages of Esthec is that you are no longer limited to the traditional look of planking running from fore to aft. You can virtually design your own style of deck, including swirls, whirls and patterns of all kinds.

PlasTeak (www.plasteak.com) is another synthetic option, but this one is made from recycled materials. Unlike caulked teak decking, PlasTeak is made in teak-and-holly style sheets that are cut to the desired length. As such, it can be used both inside the boat and on open deck surfaces, such as sun decks, fishing cockpits, dinghy floors and other outdoor applications. When ordering PlasTeak, which comes in 60- or 70-inch-wide rolls, you simply specify a particular length. Then you cut the material to shape and glue it into place.

Another option is NuTeak (www.nuteak.com), which comes in two forms: rigid and flexible. The rigid material is a wood and PVC composite that comes in 2-inch-wide, tongue-and-groove planks, complete with a strip of faux caulking on one edge. The flexible material is available in three widths (1.77, 2.35 and 2.95 inches). As its name implies, it is flexible and easy to install using glues provided by the company. It is also colorfast, nonslip, nonporous and has a strip of caulking to make it look authentic. The caulking strip slips into a groove on the edge of the next strip, giving a teak deck look without the need for fasteners other than glue.

One brand-new product from Italy, called MitTeak (www.mit-labs.com), was on display at the Marine Equipment Trade Show in November. It uses less than perfect teak veneers, which are glued together and then cut and set on edge to form decking. Instead of seeing the full face of the teak as you normally would, you see the edges of many thin slices laminated together. On first inspection, it is very hard to discern the separate veneers that make up this material. You would think it's natural teak.

And that, for all of these products, is the very idea. **DIY**

Battery of Options

Breakthroughs in Technology Could Change The Way We Power Our Boats

By Tom Tripp

Battery problems are one of the most pervasive issues boaters deal with, year after year. In fact, dead batteries were the second most common reason help was requested out on the water from BoatUS last year, according to Jerry Cardarelli, vice president of BoatUS Towing Services.

While boaters may be taking shortcuts on battery maintenance in a poor economy, the irony is that battery troubles are one of the most avoidable problems—and they may be getting even more so. Several companies have released new batteries on the market that promise dramatic performance enhancements, including more power and more utility in a smaller and lighter package.

From lithium-ion batteries, which are brand new to the U.S. marine market, to advancements in AGM battery technology, the latest power cells are worth watching. They may cost more. And some of this technology is first generation. But it may dramatically expand your power capabilities in the years ahead.

Odyssey

Manufacturers like Odyssey are unleashing new technology, such as the Thin Plate Pure Lead (TPPL) battery.

AGM EVOLUTION

Traditionally, marine batteries have fallen into two camps: starting batteries and deep cycle batteries. Starting batteries were required to deliver more power in a short period of time, as they would to crank a cold engine, while deep cycle batteries were required to deliver smaller amounts of power over a longer period of time to run lights, instruments and other equipment.

In flooded lead-acid batteries, the kind most of us grew up with, the two requirements were not compatible and required different designs (you can still buy lead-acid batteries in either configuration). But Absorbed Glass Mat (AGM) batteries, which use a porous glass mat between the lead sheets, allowing them to be packed much closer together, can be used for both charging and deep cycle applications. They can also be used in almost any orientation, to save space or improve access, and have a longer shelf life. And it is this AGM architecture that has companies bringing new innovations to market.

Odyssey batteries from EnerSys, for example, patented what the company calls Thin Plate Pure Lead (TPPL) technology, which makes it possible to pack in more and thinner lead plates for higher power, according to Bruce Essig, sales director for Odyssey. The plates are also coated with a more dense oxide paste, which allows for better recovery from deep discharging. The design helps the batteries deliver a lot of power for starting and still recover nicely from a deep discharge, according to the company.

Odyssey batteries also have a much longer shelf life and don't need to be trickle-charged in the off-season, Essig said, adding that many boaters will be able to simply disconnect the batteries in winter and then reconnect them in spring, having lost minimal charge. Try that with your flooded lead-acid battery, and you'll be disappointed come launch day.

Essig said that Odyssey's batteries may also last much longer than flooded cell batteries. The batteries are designed for a nominal 12-year life cycle, versus the three to four years one might expect of a conventional battery. According to Essig, the Odyssey batteries cost about 2.5 times as much as an old-technology battery. Odyssey's batteries are certified as nonhazardous by the U.S. Department of

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Tom Tripp is a freelance writer whose work has appeared on Mad Mariner.com, *and in* Northeast Boating, Chesapeake Bay Magazine *and other publications. He blogs about passagemaking at www.oceanlines.biz.*

Transportation and the International Air Transport Association, which means they can be shipped by almost any means.

Of course, other manufacturers also have technology advancements.

Mastervolt offers a Slimline AGM battery for high power-density applications. A boater could install two Slimline AGMs with 400 amp-hours of total capacity into one battery box designed for a standard 8D battery, which typically weighs four times more and offers only 250 amp-hours of power. You won't gain a cost advantage, but you can basically double the amount of power for a given space, which is often at a premium.

Lead-acid batteries may have one last gasp if the technology developed by Firefly Energy takes hold. The company was founded in 2003 to take advantage of a new lead-acid battery design by a Caterpillar scientist. The innovation involves replacing the conventional lead grid in these batteries with one made from carbon graphite foam.

The new grid resists both corrosion and sulfation, the two damaging byproducts of the charge-discharge cycle in a battery. Firefly says this allows its batteries to maintain a much higher level of power capacity, up to 90 percent of the original rating, for more than 1,000 cycles. So far, the only product on the market is a Group 31 battery being used in long-haul trucks to power the air-conditioning systems when the trucks are stopped. But it is worth watching.

LITHIUM ION

The newest battery technology, now familiar to most of us in many applications ashore, is the lithium-ion battery. Mastervolt is the leader in bringing lithium-ion technology to the marine market, and for good reason.

"You're getting more families on board, and they want the creature comforts of home," says Michele Goldsmith, director of sales for Mastervolt in the United States. "In order to make all that stuff work, you need much more battery power to go with it."

The first Mastervolt lithium-ion batteries are 24-volt models and were introduced in the U.S. in October, winning an Innovation Award at the International Boatbuilders Exhibition and Conference. Goldsmith says the first 12-volt batteries will be available this summer.

The company spent a significant amount of time and money adapting lithium-ion technology to the marine environment, which required substantial changes in battery chemistry. The result: This is not quite the same as your laptop battery.

A typical laptop battery uses a lithium-ion cobalt makeup, which is more powerful in terms of the volts available per cell than the marine batteries but is less stable and has a shorter life cycle. Mastervolt's marine batteries use a lithium-ion phosphate chemistry, which is the most stable of the lithium chemistries and has a far longer life expectancy. For example, Goldsmith says these batteries can be discharged 80 percent for 2,000 cycles. That compares to cycles numbered in the hundreds for flooded lead-acid batteries and perhaps as high as 1,000 for a premium AGM battery. The weight advantage for lithium-ion batteries is also dramatic. One of Mastervolt's new 24V/160Ah batteries, weighing only 88 pounds (40 kg), can replace two lead-acid gel batteries weighing 308 pounds (140 kg).

These new lithium-ion batteries can also be discharged and recharged in as little as an hour, which could have a major impact on battery bank design for boats. Today's house battery banks typically have a great deal of overcapacity—adding cost and weight—to accommodate recharging times that can run many hours.

Mastervolt

Mastervolt's lithium-ion batteries are a potential game changer, adapting the technology to a marine environment.

Mastervolt has also developed additional technology. For example, the new batteries are manufactured with sophisticated cell-balancing technology, so that the battery's performance is not limited to its least-charged cell. They also are made with a built-in CAN Bus data system, which allows the battery to communicate over a bus with virtually any suitable network device, using regular Cat 5 networking cable. This lets the batteries "talk" to devices such as a marine system monitor over a NMEA 2000 marine electronics network.

And it may enable more sophisticated techniques moving forward. Imagine a system where you install a SIM card device that can tell your cell phone how the batteries on the boat are doing, and in turn can take instructions from you to turn on the battery charger—or anything else in the system. Mastervolt makes an entire range of devices that can communicate with each other, from isolation transformers to switches and smart, touch-screen panels.

As a Dutch company, Mastervolt was especially sensitive to the special demands of European boaters for more efficient DC power systems on their boats. It's still new to most boaters in the U.S., and the prices reflect that. A Mastervolt 24V battery is about three times the price of an equivalent lead-acid gel battery, but the company says that because a boater can expect three times the number of cycles, the cost is comparable over time.

Goldsmith likens the experience to that of flat-screen TVs. "Over time," she said, "they became much more popular and the prices came down significantly." She noted that the price of lithium-ion batteries for boats already has dropped by 10 to 20 percent.

While the cost of many new battery technologies may give boaters pause, the possibilities are apt to spark some imaginations as these products get wider use. Whatever your power needs, it pays to keep an eye on what the scientists are doing. **DIY**

Winch Cleaning

Without Service, Grinding the Winch Means Taking in Dirt, Not the Sheets

By Nonnie Thompson

Not long ago, the winches aboard our 50-foot Able Apogee began grinding harder and rougher. We realized that in restoring our 10-year-old boat, we had yet to get to the winches. Looking closely, we could see chunky black grease and sticky dust slurping sideways. The time had come for cleaning. In fact, we were overdue.

Lewmar's Winch Service Manual says: "Winches are required to carry deceptively high loads. Regular servicing, with attention to correct assembly and condition of parts, is vital to the safety and performance of your boat. Winches should be stripped, cleaned and relubricated two or three times during active sailing season, at the end of each season & before starting the new season."

The manual was easy to follow, a detailed companion to the work ahead. My husband, David, and I set to the task. Clearly, we needed to disassemble, soak and scrub each and every part, then wipe, dry, align, grease or oil, and reconstruct, replacing damaged parts as needed.

First, I counted the winches. Our boat has a healthy winch supply: five 44s, two 58s, two 62s and one electric 50, all Lewmar and all self-tailing. Very nice, but servicing 10 could take some time. In fact, it took two weekends. First, we gathered the tools: Allen wrench, screwdrivers, a bucket of liquid paraffin oil for soaking and cleaning, towels, toothbrushes and wire brushes, fresh grease, light oil and good rubber gloves. And the digital camera: Being older and wiser (and forgetful), we wanted digital photo reference of each phase.

We began with a beautiful day (no point getting the buggers wet or losing parts in a stiff breeze). Then, we chose two identical winches in the cockpit, so we could mirror each other's process. For a clean, contained work surface, we set a sheet of flat cardboard on a cockpit bench. The process is simple, though I counted 47 parts, plus the center spindle. The parts are heavy to tiny, chunky to delicate. Methodically, I worked my way through the winch. The process may be different for winches from different manufacturers, but this will give you some idea of the project.

First, I unscrewed the top cap and removed it by hand, checking the O-ring in the cap for wear and damage. Next, I removed the feeder arm, then the crown assembly using a Phillips screwdriver or Allen wrench. You must be careful when pulling the lower crown, watching for springs that may have come loose from the drum. Remove the springs and the spring cups.

Nonnie Thompson is a freelance writer and photographer, licensed USCG captain, US Sailing instructor and blue water cruiser. With her husband, David, she's sailed over 20,000 miles. They are currently commissioning their Able Apogee 50 for world voyaging and sail training.

While firmly holding the main spindle, I removed the collets, then the spindle. I removed the drum to reveal the gear assembly, then the roller bearings and spacer. Using a sharp screwdriver, I lifted out the gear spindles, which hold the ratchets and pawl gears in place. Then I removed the ratchets and pawl gears.

When disassembling the pawl gear from the ratchet gear, watch for loose pawls and their tiny springs. Inspect for wear and replace as needed. Remember, these are among the most important internal parts of your winch, and the least costly to replace. Don't wait for them to break before changing them. It is the sprung pawl within the ratchet that does the click-clicking when the winch bears a load. Note how the assembly works, the direction of the pawls and springs. This is the only really tricky part of proper reassembly.

As you go, soak greasy parts in a paraffin bucket. Then wipe or scrub each piece carefully with a toothbrush and clean rags. I wore rubber gloves when working in the paraffin/kerosene, because it can be tough on the skin. Wipe all parts thoroughly dry, checking for wear and damage. Clean center stem, inside and out, then prepare to reassemble.

Use light oil for pawls, never grease. And use it sparingly. Lewmar says, "Use only a light smear of winch grease when lubricating ratchet tracks, gear teeth and bearings. Otherwise, excess grease will be forced out and will collect in potentially dangerous areas, such as pawl pockets." Overlubricating may attract salt and dirt and increase friction. We used Lewmar GearGrease and RaceLube winch oil. Most winch companies sell their own grease in tubes.

photos by Nonnie Thompson

Make sure to check pawls and springs for wear, and lay out all the parts on a level, clear space to make reassembly a breeze.

You must reassemble in reverse order, which is why the digital photos saved us a lot of time—we were sure to get it right, going backwards. Each winch, size and brand will be a little different, but basic principles apply. When you get the drum back on, give it a spin. You should hear a light, metallic clicking sound—music to the ears.

I know how to work a winch. But how it actually worked, I didn't know until our cleaning job. The beauty of rebuilding my own winch: I've seen how the pawls and springs fit and catch, seen how the gears and bearings roll, and held each piece in my hand, turned it over and looked at all angles. I see why they need to be cleaned of grit and freshly greased. And with each winch, the job went faster. By the 10th, we had it down to an hour's work. As I reconstructed each winch, carefully greasing and fitting the perfectly tooled parts, I gained a new sense of the safety and power of my boat.

Now when we refer to "grinding the winch," I know we're grinding in the sheet, not grinding old, dirty, damaging grease into the gears. **DIY**

Building a Better Bucket

Getting the Most From Your 5-Gallon Friend

By Glen Justice

I love my 5-gallon bucket.

I have tried others—smaller buckets, square buckets, canvas bags and folding buckets—but I keep coming back to my round, plastic friend.

It helps wash the boat. It holds things like line and tools. It makes a great seat when I work on projects. It's not such a great bailer—too big—but it can entertain my two young boys for an hour or so, as they repeatedly throw it over the side and haul it back with a rope.

It started as a standard white 5-gallon bucket of the sort that holds paint. I don't recall where I got it, but I have customized it over time. Last year, I added a lid from Sawgrass Industries (www.sawgrassusa.com), so it can sit on deck without collecting rain. More recently, I added a Bucket Stop (www.thebucketstop.com), a rubber ring that prevents it from spilling or sliding when I scrub the boat.

Did I really need this stuff? No. Did it help me get some jobs done and make life on the boat a little easier? Yes. Both were pretty good additions that cost only a few bucks.

Then, obsession kicked in—what else could I do with a simple, 5-gallon plastic bucket? Turns out, quite a bit.

A look around the Internet revealed attachments to turn it into a wet-and-dry shop vac; inserts to organize screws and hardware; cushions to sit on; dollies to roll around; a kit to turn it into aerated livewell, complete with cutting board top; and more tool bags than I ever thought possible. Grainger, the industrial supplier, alone had almost a dozen.

And so, I got out my credit card. Over the next few weeks, I will try some of this stuff and report my findings on DIY-Boat.com. The goal is to see just how much utility I can get out of a lowly 5-gallon can.

I realize that this is a plan laced with madness, the brainchild of a man made crazy by winter and the wait to get back on the water. And so I beg your indulgence. Do we really need to build the world's most useful—and expensive—marine bucket? No. Will we have some fun with it? Absolutely. **DIY**

Five Gallon Fun

Read more as we kick the bucket up a notch on DIY's Solutions Center. Visit **www.DIY-Boat.com**.

Ask the Experts

Fuel Economy. Protecting Rubber Outdrive Bellows. Our Experts Weigh In.

I have a 17-foot Starcraft Bowrider. It's powered by a 90 horsepower, 4-stroke Mercury, and an 8 horsepower, 4-stroke Yamaha kicker. The lake on which I fish is long and narrow and subject to very windy conditions. My optimum trolling speed is 3.5 to 4 mph. I have more maneuverability using my main motor in these windy conditions, plus it is quieter than the kicker. My question is: Which motor would use more gas under similar conditions?

– Vic.

To understand the principles at work here, you need to understand what's going on below the waterline at these speeds. The vast majority of the work that any outboard does on a modern powerboat is getting you up and on plane.

That's why displacement hulls (which don't plane at all) can get by with such tiny power plants—it takes far fewer horses to attain maximum hull speed (hull speed = 1.34 x square root of hull length) than it does to exceed it. In fact, efficient displacement hull designs in good conditions require a mere 2 horsepower per ton to attain hull speed. Inefficient designs in poor conditions rarely need more than 5 horses per ton.

When trolling, you are moving at displacement speeds, as opposed to planing. Since your boat is 17 feet long, the theoretical hull speed is 5.52 knots. Any time you're traveling below this speed, the kicker won't have to work very hard at all, and as a result, the two motors will be spinning in similar RPM ranges.

Of course, we don't live in a theoretical world and many other factors come into play (prop size and weight distribution, to name just a couple), but as a general rule, your 90 should be turning between 1100 and 1300 rpm and burning between 0.3 and 0.5 gallons per hour to attain your desired trolling speed. You kicker should be turning between 1200 and 1500 to reach the same speed, while burning between 0.075 and 0.15 gallons per hour. The short version: Your kicker will burn significantly less fuel.

– Lenny Rudow

Is there a product to preserve and protect the rubber outdrive bellows from UV damage or to maintain flexibility and prevent cracking? If a crack or tear appears, can it be patched or repaired like a tire tube? Can tire coatings (rub-on or spray foam) be used without damaging the bellows?

– Earl Westerling

The information in **Ask the Experts** *is advice only and should not be used as a substitute for the services or opinions of a marine professional who can directly assess your boat and equipment.*

We checked with two major outdrive manufacturers, Volvo and Mercury Marine. Both said that they do not know of a product to repair an outdrive bellows. Both said they expect to see a product come onto the market in the next year or so. Representatives from both manufacturers said that dirt and growth on the bellows are the biggest problems consumers face.

They recommend that you wash the rubber seals carefully at the end of each season and make sure that there is no marine growth that can cause friction on the rubber while the boat is in use. Do not paint the bellows or the outdrive with copper-based anti-fouling paint. Copper reacts with the aluminum construction and can ruin the entire unit.

– Roger Marshall

Tech Tips

FUEL TANK PULL-THROUGH

I recently removed the diesel fuel tank from my 1986 Ericson 32-II Whispering Swan for cleaning and to replace aging fuel lines.


Chip Lohman

In order to facilitate using the old fuel line as a pull-through, making it easier to install the new fuel line, I used a wooden plug to join the old and new lines.

Using a hole saw, I was able to cut an inexpensive wooden plug to join both lines using wood screws. This formed a strong joint, without having to purchase unnecessary plumbing fittings or mess with adhesives.

– Chip Lohman

HOMEMADE WATERPROOF CHARTS

Most of us who boat in the Pacific Northwest, as well as other areas in the U.S. that have a lot of rain, probably have had problems with soggy paper charts, doused when they were left in an exposed area of the boat.

The solution? Paint the paper charts with Thompson's Water Seal. It is available in most hardware stores (I always have some left over after treating our decks at home). Let them dry for about 15 minutes, and you end up with inexpensive waterproof charts.

One downside is that pens do not work very well on the sealed charts, but pencils work just fine.

—Ken Sampson

MANY USES FOR 'BANDING FILM'

Rolled plastic wrap on a handle, known commercially as "banding film" and available for less than $10 on the Internet, has many uses on a boat.


Glen Justice

It's great for keeping like objects in the same place. Let's say you use an ice eater during winter and you want to keep the zincs and other replacement parts with the unit when you store it during the season. No need for a separate bag—just wrap the parts to the unit itself and cut them free when you need them.

It can also be a pretty good storage tool, as you can see on the kayak pictured above. Simply make sure the boat it is dry, and wrap it up. It takes about 20 minutes and can be done by one person. When you need the boat, just cut off the plastic and launch.

Banding film comes in many sizes and configurations, with and without handles.

—Glen Justice




photos by Chris Ferro

Ditching Datamarine

How to Replace an Old Datamarine Unit with a Modern Unit

By Chris Ferro

For the past few years, the needle on my 1983 Datamarine wind instrument flopped around uselessly while I steered by telltales and the feel of the wind on my cheeks. If I wanted to know the wind speed, all I could do was squint at the barely discernible LCD screen, look up at the wobbly, spinning cups and try to guess how many knots I should add to the reading. I finally decided to replace the whole system.

But where to start? My main concern was finding a large, clear display, a unit that showed maximum wind speed memory and a reasonable price. Starting at the low end, the Moor CAPW, Raymarine's ST40 and the British NASA Clipper, along with the much more expensive TackTick and Simrad IS20 systems, don't retain maximum wind speed stats, so I eliminated them from contention right away. The high-end Raymarine ST 70, Maretron, NKE and B&G systems are just too expensive for reason on my old 1983 Seidelmann 30T.

Echopilot's Windmaster, another European option on the pricey side, has a small, monochromatic display. The Furuno FI 501 has an excellent display and a nifty auto-backlight feature but is also pretty expensive. Raymarine's ST 290 is cheaper but the display is small. The Garmin GMI 10 and Raymarine ST 60Plus were strong candidates, but in the final analysis, the lower-tech Northstar W315 won out with its lower price, large digits, clear and colorful display, and package of features that included max wind speed.

Chris Ferro is in the midst of updating his 1983 Seidelmann 30T for another summer of cruising the Chesapeake.

Since there must have been a law dictating that all boats made in the 1970s and '80s have Datamarine instruments, and because Northstar's design is similar to other systems, my installation specifics should apply to many boats.

To begin with, no matter which system you're installing, you'll first have to get rid of that old Datamarine unit, which is basically a metal, 4-inch diameter tube that goes through the bulkhead and is secured by two rings, one on the inside of the boat and one outside.

After removing the masthead and power cables, I removed the inside ring by unscrewing the tiny set screws on the outside perimeter of the ring, as well as the screws that attach the ring to the bulkhead. The other, outside ring is threaded onto the outside of the tube but was held in place by sealant, so I used a chisel to pry the ring away from the bulkhead. Once it was separated, I unscrewed it and used a mallet to knock the entire unit out. There was quite a lot of sealant holding it in place, and I used the chisel and a knife to remove as much of it as I could to separate the tubular unit from the boat itself. I didn't want to use too much force with the mallet for fear of cracking fiberglass.

What remained was a round, 4-inch hole—too big for the Northstar's 2-inch diameter tubular back. My plan was to cover the hole with a 4.5-inch square piece of white ¼-inch Starboard, with a 2-inch hole in the middle. To secure the Starboard, I wanted to screw it down as well as use 3M 5200, so I dug out about an inch of the balsa core around the hole and packed it with epoxy putty. That would ensure that the screws would grab epoxy and not balsa, and protect the core from water. There was also a thin, black rubber gasket around the hole, which would be mostly hidden behind the starboard, but I had to scrape it and sand it away where it might show.

With the Starboard glued and screwed in place, and with an additional 5200 fillet around the outer edges, I inserted the new unit, using a healthy slathering of plumber's putty under it to help keep water from entering the boat. Then, on the inside of the boat, I screwed the unit's locking nut onto the threaded tube until it was snug and locked into its new position. For cosmetic purposes, I added a stained, square, 5.5-inch piece of ½-inch teak trim to hide the old screw holes and the messy white putty.

At the top of the mast, I removed the old masthead unit and attempted to install the new unit with the mast in place. My plan had been to use the old cable as a messenger to pull down the new one, but that old cable wouldn't budge. Since there wasn't any room in the wiring track to add the new cable, I had to have the marina pull the mast during winter haul-out. Once the mast was laying on the ground, it was a simple matter of sliding the cover off of the wiring track, swapping cables, screwing the new masthead unit into place and replacing the track cover.

In the spring, when the boat goes back in the water, I'll have the marina reinstall the mast, and then I'll connect the masthead cable to the display and calibrate it. Because the mast looked like it hadn't ever been pulled (the mast step was welded by corrosion to the keel—what the marina riggers called "unimetal"), it provided a good opportunity to thoroughly inspect, repair and replace various components. Hopefully, now the boat will be ready for the next 26 years.

A piece of Starboard was used to hide the old holes and mount the new unit.

The display part of the project took about three hours from start to finish. The total cost was $640. The Northstar W315 with Masthead Unit and 30 meters of cable made up the lion's share of the budget at $600. I spent $22 on a piece of teak, $8 on some Starboard and $10 on a tube of Mighty Putty.

The masthead portion of the project was much quicker and easier, except for the time and cost ($690) of removing and replacing the mast. **DIY**

Cover Story

Do You Know Your Onboard Electricity Needs – *Really*?

Conducting a Power Audit Can Give You the Numbers You Need (and One Heck of an Education)

By Paul Esterle

Remember the good old days, when a boat's electrical system was little more than a single battery, some running lights and a bulb or three in the cabin?

It's fun to think about when you consider today's vessels, where electronics suites, power winches, entertainment systems and even full-size electric stoves and refrigerators require banks of batteries and a hold full of gear to charge them. The swollen electrical loads have increased the burden on captain and crew, too. We need to understand these systems—and it's not always easy.

While the thought of dissecting your power system may cause your brain to short-circuit, a failure to understand what keeps the lights on can have consequences. You don't want to awake in an anchorage to find that the coffee machine won't brew—or that the engines won't start.

The good news is that taking stock of your system—call it a power inventory or an energy audit—is something that almost every boat owner can do with a weekend of work and a little bit of patience. It's a low-cost way to get better acquainted with your boat. Veterans can do this when they add equipment or revamp systems. Beginners will find that it is quite an education.

The basic drill is simple: listing the power requirements of your equipment, figuring out how much you use at any given time it and then using that information to develop a profile of your energy needs. You can then compare that profile with the amount of power your boat can produce at any given time and adjust accordingly.

You may decide to restrict your power consumption. Or perhaps you will decide to invest in equipment like a generator or a second alternator to produce more energy. Either way, you will have more control over your fate—and less chance of waking up to a blackout.

DOING THE NUMBERS

When addressing the DC side of the equation, the first step in our energy audit is to list all the equipment on the boat that draws power from the batteries. Because electrical devices consume power measured in amperes, or amps, the goal is to list the draw in amps for each device. We'll then use that to calculate a measure called amp-hours (often abbreviated Ah). An amp-hour is simply the amount of power consumed by a device during a period of one hour. We'll use that measure to

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Paul Esterle is technical editor for Small Craft Advisor Magazine*, and his freelance work has appeared in* Sail, BoatWorks, Voyaging *and* Good Old Boat *magazines. He has produced a series of boating videos and lectures widely. He also runs a Web site called www.thevirtualboatyard.com* calculate the boat's daily power consumption.

Most gear will have the amperage or wattage (sometimes both) listed on the manufacturer's label or in the manual. We are going to list all the gear, along with its draw in amps and watts. Start by simply inspecting the equipment and then turn to the Internet to fill in the blanks. Listing the numbers for each piece of gear on paper will work fine, but a spreadsheet on a computer is even easier. It can do the math for you—and there will be some math.

To help illustrate this process, we developed a sample energy audit for the hypothetical vessel M/V Slo-Poke (*see table on page 33*). The numbers and usage times are estimates—so don't use them as your own. But it should give you an idea of what your audit should look like.

As you will see, evaluating a boat's electrical system requires some basic math skills. Nothing elaborate, just a couple of easy formulae. In cases where you have only partial information, for example, a simple formula can help you calculate what you need, which in this case is amps. Let's say that you come across a piece of gear in your 12-volt system that is rated only in watts, which is fairly common. You can use this simple formula to calculate the draw in amps: Watts ÷ Volts = Amps. So, for example, to calculate the amperage of a 12-volt, 10-watt light, we would plug the numbers into the formula: 10 ÷ 12 = 0.83. The light draws 0.83 amps.

When the numbers are complete, we use a second useful formula to calculate amp-hours: Amps x Time = Amp-Hours. Time is simply the amount of time you use the device each day. To use our example from above, if the 10-watt, 12-volt light was used for four hours a day, it would consume 0.83 amps x 4 hours, or 3.32 amp-hours (you can see where putting this all into a spreadsheet makes the job easier).

Obviously, part of arriving at a list of equipment with amp-hours is estimating how much time, measured in hours, you use your gear each day on the water. This will be different for every boater—and it pays to be honest. Record what you do, not what you think you should do. If you routinely leave the chartplotter and the radar on all night at anchor, then count those hours. If the kids watch television for five hours and then sleep with the cabin lights on, reflect that in your audit. Low-balling the numbers won't put anymore amp-hours in your batteries, so be as realistic as possible.

When you are finished, you will have a list of DC-powered gear and how much it draws from the batteries during the amount of time that you use it. By adding it up, you have the estimated number of amp-hours of 12-volt DC power required each day.

ADDING IN AC

So far, things have been relatively simple. Here is where the complications start. Most modern boats have

Be honest when evaluating your consumption. Low-balling numbers won't put amp-hours in your batteries.

120-volt AC power systems in addition to DC power. In times past, these were used only when connected to shore power, but today air conditioners, hair dryers, blenders and coffee makers are just as often run on the water, using a generator or inverter. (Yes, they do make 12-volt appliances, but the 120-volt household models are typically cheaper, more powerful and certainly easier to come by.)

So it's time to add another section to the energy audit worksheet, this one for AC devices. Use the same process, recording voltage, amps and, this time, the watts. If watts aren't provided, use the formula to calculate them (Volts x Amps = Watts). Give it a watt-hour rating (Watts x Time) and estimate daily usage. As a last step, add in how each item on your list is powered: generator, inverter or shore power.

When you are done, you will have a complete energy audit, listing the consumption for both the AC and DC systems and calibrated to how you use your boat.

Note, however, that you are probably not going to use every single thing all at once. Rather, you probably use certain gear in combination, while other items sit idle. For example, you might run lights and your radar overnight in an anchorage, but not the windlass. Play around with your numbers so that they reflect accurate usage—and add in real-world experience. Remember that the audit starts as an estimate. By paying attention to your actual usage and refining your calculations, you can make it more accurate over time. And be sure to update it when you add devices.

THE SUPPLY SIDE

Of course, evaluating your power consumption is only half the job when it comes to understanding your boat's electrical capabilities and limitations. You have to know the supply side—how much power you can generate in your AC and DC systems—to get the full picture.

Let's look at the DC side first, which means taking stock of your battery bank. The vast majority of marine battery banks consist of flooded-cell, AGM or Gel Cell lead-acid batteries. Each battery has slightly different charge and discharge characteristics, which must be accounted for, especially when charging. Powering DC loads (as opposed to starting an engine) requires deep cycle batteries, which are optimized to survive many charge-and-discharge cycles at a deeper discharge level than a typical engine battery.

Deep cycle batteries carry an amp-hour rating. For example, a rating of 200 Ah means that battery could theoretically provide 200 amps for one hour or 1 amp for 200 hours before being completely discharged. As a rule of thumb, lead-acid batteries should never be discharged below 50 percent, which means, in this example, the battery would provide 100 amp-hours. Deeper discharge levels shorten battery life considerably.

Your energy audit will give you a strong idea of your consumption in amp-hours. The next step is to find out how much battery capacity—also in amp hours—you have aboard, accounting for the 50 percent discharge rule. Look at your batteries, or the manuals, and do the math.

Evaluating power consumption is only half the job. You have to know the supply side.

On the M/V Slo-Poke, our example from the energy audit, the consumption is 249.0 Ah per day. So, given a 50 percent discharge, that equates to a battery bank with about 500 Ah of battery capacity. This would be sufficient to run the boat for a day without additional energy to recharge the batteries from shore power, solar or wind power, running the engine (to drive the alternator) or the generator. A typical Group 31 marine deep cycle battery is rated at 105 Ah. That means that a 500-Ah battery bank aboard the boat would require five such batteries.

GENERATORS AND INVERTERS

If you are depending strictly on a shore connection for AC power, you are largely finished with this process. Shore power is likely to fulfill your energy needs, so calculations are unnecessary. However, very few boaters these days limit themselves to shore connections. Most want AC power out on the water, and that usually comes from a generator or an inverter.

Inverters are fine for variable demands up to about 3000 watts. Generators are better suited for larger continuous loads, such as air conditioning, cooking and refrigeration. A general rule of thumb is if your daily consumption in watt-hours exceeds 2000, that's a load worthy of a generator. For our purposes here, the goal is to determine how adequately your generator or inverter (or the one you plan to add) will cover your power needs.

Let's start with the generator. Look at your power audit, determine which of your AC devices you will be using at the same time and arrive at a number, in watt-hours, for your overall needs.

If you have the right size generator, that number should represent 50 to 75 percent of the generator's rated output. If it falls below 50 percent, the engine driving the generator isn't operating at a fuel-efficient power level. If it is above 75 percent, you risk not having enough excess capacity to allow for the start-up surge associated with certain types of devices (air conditioning, for example, may require more power to start than it does to run). Operating below 75 percent of capacity will also allow you to add additional AC devices over time.

For those running diesel generators, these percentages become particularly important. Diesels must be run

Need some help on your power inventory?

We have a spreadsheet you can download to help get you started. All you have to do is go to DIY-Boat.com at the address below, read the instructions and download the spreadsheet to your computer. You can then fill in the spreadsheet with your information (remember to check the math and be sure the spreadsheet is configured correctly for your boat).

www.diy-boat.com/resources/energy-audit

Sample Energy Audit for M/V Slo-Poke

DC Electrical Systems

Device	Volts	Amps	Watts	Time Per Day (Hours)	Amp-Hours
Nav lights	12	2.1		4.0	8.4
Main cabin lights	12	4.2	50.4	3.0	12.6
V-berth lights	12	2.5	30.0	2.0	5.0
Cockpit lights	12	1.4		3.0	4.2
V-berth fans	12	0.6		6.0	3.6
Anchor lights	12	0.7		10.0	7.0
Instrument lights	12	1.4		4.0	5.6
Spotlight	12	10.0		0.5	5.0
Fixed VHF radio (transmit)	12	5.5		0.5	2.8
Fixed VHF radio (receive)	12	1.5		6.0	9.0
Chartplotter	12	1.5		6.0	9.0
Depth sounder	12	1.8	21.6	6.0	10.8
Autopilot	12	3.0		6.0	18.0
Radar	12	3.5		6.0	21.0
Stereo system	12	8.5		2.0	17.0
Inverter	12	15.0		4.0	60.0
Bilge pump 1	12	2.5		1.0	2.5
Bilge pump 2	12	15.0		0.5	7.5
Windlass	12	80.0		0.5	40.0
				TOTAL	**249.0** *Ah daily use*

AC Electrical Systems

Device	Volts	Amps	Watts	Time Per Day (Hours)	Power Source	Watt-Hours	DC Amp-Hours
Stove	115		2,400	1	G or S	2,400	
Refrigerator	115	0.4	46	24	G or S	1,104	
Air conditioner	115	9.4	1,081	8	G or S	8,648	
Battery charger	115	25	2,875	3	G or S	8,625	
Hair dryer	115		1,600	0.5	I	800	80
Coffee maker	115		1,200	0.3	I	360	36
Blender	115		300	0.2	I	60	6
Toaster	115		1,146	0.1	I	114.6	11.46
Microwave	115		1,500	0.3	I	450	45
Washer	115		2,790	0.5	G or S	1395	
Dryer	115	13	1,495	0.5	G or S	747.5	
TV	115		61	3	I	183	18.3
Vacuum cleaner	115		630	0.1	I	63	6.3
Drill	115	5.2	598	0.2	I	119.6	11.96
Water heater	115	12.5	1,437.5	2	G or S	2,875	
					TOTALS	**27,944.7**	**215.02**

G or S = Generator or Shore power
I = Inverter power


Mastervolt

Knowing the capabilities of your battery bank in amp-hours is essential.

under load to prevent carbon deposits from building up in the engine. So the load on a diesel generator must be adequate—without overloading it. Gas generators have no such requirement.

When evaluating an inverter, the key concept to understand is that the power it provides comes from the boat's DC battery bank. And that means the power it needs to run equipment must be reflected on the DC side of your energy audit. To do this, you can calculate amp-hour numbers for your AC equipment powered by the inverter, then add those numbers to the DC side of your audit. A quick and dirty method is to divide the watt-hour rating by 10 to estimate the amp-hours required to provide this power from the DC system.

If you have systems to recharge batteries on board, you'll need to know how fast they can perform their task, in order to truly understand your capabilities.

Inverters normally have two ratings: maximum continuous watts and peak or surge watts. That surge or peak rating takes into account the start-up loads on the device being powered. In most cases, it is about double the continuous watts, but it can run as high as three to seven times continuous watts for induction motors such as those used in air conditioners of refrigerators. Like a generator, an inverter should not be run at maximum capacity. For example, if the anticipated load is 900 watts, a 1500-watt inverter is wise. As a general rule, allow 10 to 20 percent over your estimated load. This provides a cushion for power surges and for future growth.

On our sample audit, you can see that M/V Slo-Poke uses an inverter to power a limited number of AC devices, which add up to an additional 215 Ah required of the DC battery bank. Yet the installed inverter shows 60 Ah—clearly inadequate. The crew of M/V Slo-Poke would need to reduce inverter use or install a larger inverter and battery bank.

RECHARGING THE BATTERIES

The last part of understanding power generation is something we all already know: Batteries can be recharged. If you have systems to recharge the batteries on board—and almost all of us do—you'll need to know how fast they can perform their task, in order to truly understand your capabilities.

You can rely on shore power. Running the main engine several hours a day to charge the batteries will also work, though it is an inefficient charging mechanism. You may also use solar panels, wind generators, inboard generators or add-on, high-capacity alternators to provide charging power. The key is to understand how much energy these devices provide and under what conditions. For example, the amount of power provided by a solar array will depend on the size of the array, how efficient it is, how well it is oriented toward the sun and the amount of sunlight available.

Whatever you use, there are generally two scenarios: using AC devices to charge the batteries, like shore power or a generator, or using the alternator on the main propulsion engine. In the case of AC power, there should be sufficient charging current available to keep up with the average DC load (from your audit) plus 5 to 10 percent more to properly charge the batteries. Be sure that the charger is sized adequately to provide what your boat requires.

In the case where charging current is provided by the alternator on the engine, the charging system will need to keep up with the DC load and provide sufficient additional current to charge the batteries in the time frame available. This can be estimated by taking the number of amp-hours that need to be put back in the batteries and dividing by the available charging time. Then add in the DC load to arrive at a required charging capacity. Remember, too, that systems are not 100 percent efficient. Alternator ratings can be optimistic and factors such as engine RPM and even ambient heat can reduce the charging capacity.

Of course, with many different sources of energy coming into the system, juggling all the inputs can be confusing. Many boaters choose to install a battery monitor as part of their power system to help keep it all straight. A monitor, like those made by Xantrex or Magnum Energy, will track the charging amps coming into a battery bank from many sources (they can sense whether you are hooked up to shore power or have cranked up the generator). They can track the amp-hours used, providing sort of a "gas gauge" for your battery bank. Sophisticated models can control multiple banks and provide an estimate of the power remaining. Combined with a charger, they can regulate your alternator to deliver optimized charging current.

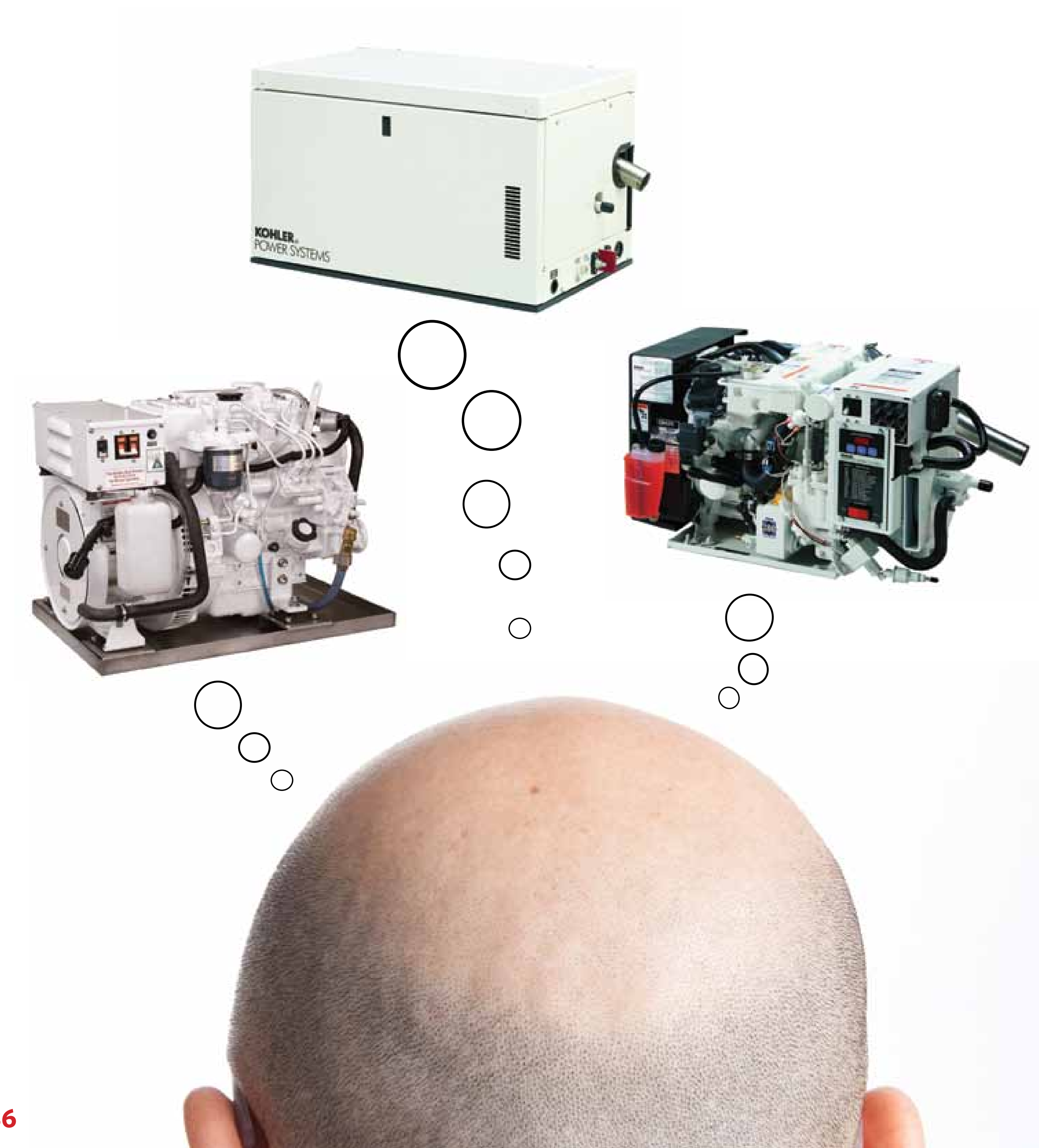
This is all very useful—but it is not a substitute for understanding your boat's electrical capabilities. Running out of power away from the dock is at least embarrassing and potentially dangerous. Performing an energy audit will give you the numbers you need to make better decisions, whether you are adding a piece of gear, replacing your existing equipment or simply wanting to cruise more efficiently and with more confidence. That's something we could all use more of—and it's something you cannot just buy. **DIY**

Want to get more out of your energy audit?

Take a few extra steps to create a document that serves more than your electrical needs.

- Create the audit in a spreadsheet, so that it will do the math for you and provide space for you to add gear. You can also plug in additional information to make the audit more useful.
- Add the make, model and year of each piece of gear you list, along with the serial number. This will be helpful if you have warranty issues, need to replace or repair something, or need to order parts.
- Add maintenance information. For example, if your generator needs service every 50 hours, add that along with the last date of service. Keep the audit updated, and it will serve as a relatively simple maintenance log.
- Add the spares required.
- If you park your spreadsheet in the right place, you will be able to access it from anywhere—home, office or boat. You could use a portable USB drive, but what if you forget it somewhere or lose it? A better idea is to use a free, Internet-based service such as Google Docs (docs.google.com), which will allow you to access your spreadsheet, make changes or download it from any computer you choose. It packs a lot of function—and the price is right.

Buying a Generator



It's a Complicated Project, But a Little Research Goes a Long Way

By Tom Tripp

There are many situations that might lead you to buy a generator. Whether you want to swap that alcohol stove for an electric unit, add air conditioning to cool those summer nights or just make sure the kids' video console never goes dark, it all comes down to wanting more electricity than you can get from a bank of batteries—and a generator can solve that problem.

What's involved in adding a generator to your boat? The most critical thing to realize that this is really two projects—one mechanical and one electrical—and that both have serious consequences for not getting it right.

On the mechanical side, you're adding another engine to your boat, with a fuel system, a starting battery and an exhaust system. They all have to be designed and installed properly. On the electrical side, you're adding alternating current (AC) electricity to a vehicle that spends its time in water—by definition, risky business.

It's a project that requires a great deal of planning. First, you have to evaluate your needs and what your boat can physically accommodate. Then, you must consider the new generator in the overall context of your boat's electrical systems, thinking through how it will affect batteries, charger, panels and other components.

Then there's choosing the generator itself. The problem is that generators, like engines, are not something we buy regularly. There are scores on the market to choose from, all with different features and benefits. They also are not cheap, with a base unit costing as much as $10,000—and that's without extras like remote panels, switches and sound enclosures. That doesn't count installation either.

But if you are willing to do some homework, you can narrow the field and start making decisions.

YOUR 'LOAD PROFILE'

Before you start shopping for the genny, figure out how much electricity you actually need. This is called establishing your "load profile," and it is relatively simple: Just add up the wattage of all the electrical devices you might be using at one time. If you don't know the wattage of a device—it's generally listed on a label or in the owner's manual—simply use the old formula: Watts = Volts x Amps. For example, a device that uses 120 volts and draws 3 amps uses 360 watts. (For a full story on how to conduct a power inventory, see the cover story in this issue.)

Establishing a proper load profile is extremely important, because the numbers you provide will ultimately determine the size of your generator. Make sure that your calculations are accurate and that you are realistic about usage. You probably won't use every single appliance onboard at the same time, so you'll have to determine what you and your crew do use. Will you be microwaving popcorn while watching TV with the A/C on? If so, account for it.

With a load profile in hand, you can determine the size range you are looking for.

GAS VS. DIESEL

Another item that can narrow the field quickly is determining whether you want a diesel- or gasoline-powered generator. For most people, that will depend on how the main power plant is fueled. Most owners don't want to have to install an entirely new fuel system to accommodate the generator.

If you're going with a gas generator, you can simply pick one that meets your electrical demands, with room to spare. If you are going with a diesel, however, you have another consideration. Diesels need to run under a significant load. They don't like to be under-loaded, which can build up carbon deposits in the engine.

"Diesel engines run optimally at an average 75 percent load factor, and should be sized based on electrical loads accordingly," said Chris Todd, marine business unit manager for Kohler Power Systems. Gas engines run happily without a load, so if you have room and money don't be afraid to buy a little more than you need.

If you are one of the few boaters for whom the gas-versus-diesel decision presents a dilemma, there are some additional considerations. Diesels offer improved fuel economy, sometimes as much as 30 percent better than gas. Some diesels, like those from Northern Lights, run at a relatively slow 1,800 RPM, which means less noise and vibration. Diesels also naturally produce extremely little carbon monoxide, historically the most dangerous issue related to gasoline generators.

Carbon monoxide, a gaseous byproduct of combustion, is tasteless, odorless and deadly. Kohler pioneered gas generators with very low carbon monoxide emissions, which may mitigate the issue. But check it out anyway. Some brands offer low carbon monoxide generators and most will offer systems to tie the generator into your CO monitors and even shut down the generator if CO is detected. Ask your dealer about emissions, and be sure you have carbon monoxide detectors on the boat.

One more note about gas versus diesel: You need to choose one or the other. Never mix gasoline engines with a diesel generator or vice versa. Gasoline engines must live in spaces with powered ventilation, and their components must be igni-

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Tom Tripp is a freelance writer whose work has appeared on Mad Mariner.com, *and in* Northeast Boating, Chesapeake Bay Magazine *and other publications. He blogs about passagemaking at www.oceanlines.biz.*

tion protected to guard against igniting volatile fuel vapors. Diesel engines do not use volatile fuel, and therefore do not require powered ventilation or ignition-protected components. Put a diesel generator in a gasoline engine space, and you have the recipe for an explosion. The same holds for putting a gas generator in a diesel engine space.

INSTALLATION CONSIDERATIONS

The next step is to determine the physical limitations of your boat. Measure the dimensions you have to work within, accounting for cooling water, exhaust and battery requirements, as well as ventilation. Be sure to account for wiring, too, as the generators will need cables running to the battery charger or AC panel, and then you'll need wiring to all your devices and for proper grounding.

The American Boat and Yacht Council (ABYC) has standards to be followed, and you should get familiar with them. The standards, which cover both the mechanical and electrical aspects of installing a generator, can affect the footprint of the installation.

The standards are not, however, "how-to" guides. Rather, they define a performance level, in terms of safety, that the equipment and installation must achieve. Log onto the ABYC Web site (www.abycinc.org) and look at the Table of Contents to see the relevant standards, such as A27 for AC Generator Sets, E-11 for AC and DC Electrical Systems and several others covering fuel systems, through-hulls and exhaust installations. The standards themselves are not available on the site, but you can purchase them from ABYC. The cost of individual standards is relatively high versus the cost of membership and the entire body of standards. If you intend to do work on your own boat that is in the category of a generator installation, the cost of an individual membership and the standards may be worthwhile.

No matter what you buy, it will have to fit. Similarly, no matter who is installing the unit, the lines will have to run cleanly, without chafe and sharp angles, and should adhere to ABYC standards. Shopping with dimensions in hand and a strong idea of how the installation will be designed makes sense.

One helpful trick is to take a look at what others have done on your boat. If it is still in production, see what model and size the manufacturer is offering as an option, as well as where and how the generator is installed. Going to a dealer and looking at an actual installation can be invaluable. If your boat is not in production, owner groups may provide similar advice. Don't be afraid to go online and post questions.

Of course, every boat will present different challenges, but there are some common problems. One large concern with generator installations, according to manufacturers, is faulty exhaust design and installation.

"The number one problem we see, and not just with DIY installations but even with some boat builders, is the exhaust system," says Colin Puckett, sales and marketing manager for Northern Lights. "An improperly designed and installed exhaust system will create back pressure on the system and create the potential for flooding the engine with sea water."

Shopping with dimensions in hand and a strong idea of how the installation will be designed will help ensure a smooth, ABYC-compliant project.

The issue arises because most generators are installed below the waterline. It is so pervasive that Northern Lights put an article on its Web site called "Don't Drown Me," which explains the phenomenon and how to avoid it.

Another issue with installation is finding an orientation that will allow you to take advantage of the recent improvements in maintenance design. Most manufacturers now are putting all the critical service items on one side of the unit, so you can get to them easily. But you need to make sure that side is easily accessed.

Remember weight and balance considerations, too. By the time you've added the genny, sound enclosure, starting battery and cooling and exhaust plumbing, you may have added several hundred pounds. Depending on your boat, that may or may not be an important consideration.

FIND A DEALER

When you have some basic ideas about your power needs, your limitations on space and what other owners are doing, the field of products should start to narrow. Choose a handful of units to examine and start talking to dealers in the areas where you do your boating (you'll want access to authorized dealers and repair centers).

Ask about performance, emissions, noise, fuel economy and anything else that is important to you—including the warranty, which is typically one year on the whole unit, with several more years covering workmanship and design.

Of course, one of the primary factors will be the price. So what will a genny cost? That will depend on what you buy and how you install it. For some examples, let's consider a load profile of 5 to 6 kilowatts, which is probably in the ballpark for boats in the range of 25 to 35 feet.

If you choose a gas generator, you might consider a Kohler 5ECD, a 5-killowatt unit and one of the new models that the company claims will eliminate 99 percent of the carbon monoxide emissions. A ballpark price for the 5ECD is $9,500 for the base unit, although deep discounts are available from some dealers. Add a remote panel, a ship-to-shore power switch and sound enclosure and the base price will grow by anywhere from $1,000 to $2,500.

If you go with diesel, the Northern Lights 5 kW M673LD3 has a list price of $10,995. The extra panel, switch and sound enclosure might be about $2,500.

You may get a better price from an authorized dealer, especially if the dealer installs the unit. If you decide to have the dealer install the unit, plan to pay for anywhere from 10 to 30 hours of labor, at whatever local rate you pay. At $80 an hour, that means $800 to $2,400.

Of course, you can install it yourself, if you have the skills to safely handle heavy work on your fuel, exhaust and electrical systems. But either way, you'll want to find a good dealer to work with. Even if you plan a DIY installation, you should run your planned installation by the dealer, who should be willing to sit with you and discuss it.

"A DIY installation does not typically impact the manufacturer's warranty, provided that all manufacturer's criteria are met," said Kohler's Todd. "The assistance of an authorized dealer can help to ensure all installation criteria are met." **DIY**

Soup's On

Installing a Stove Transformed One Galley from Fast Food to Gourmet

By Frank Mummert

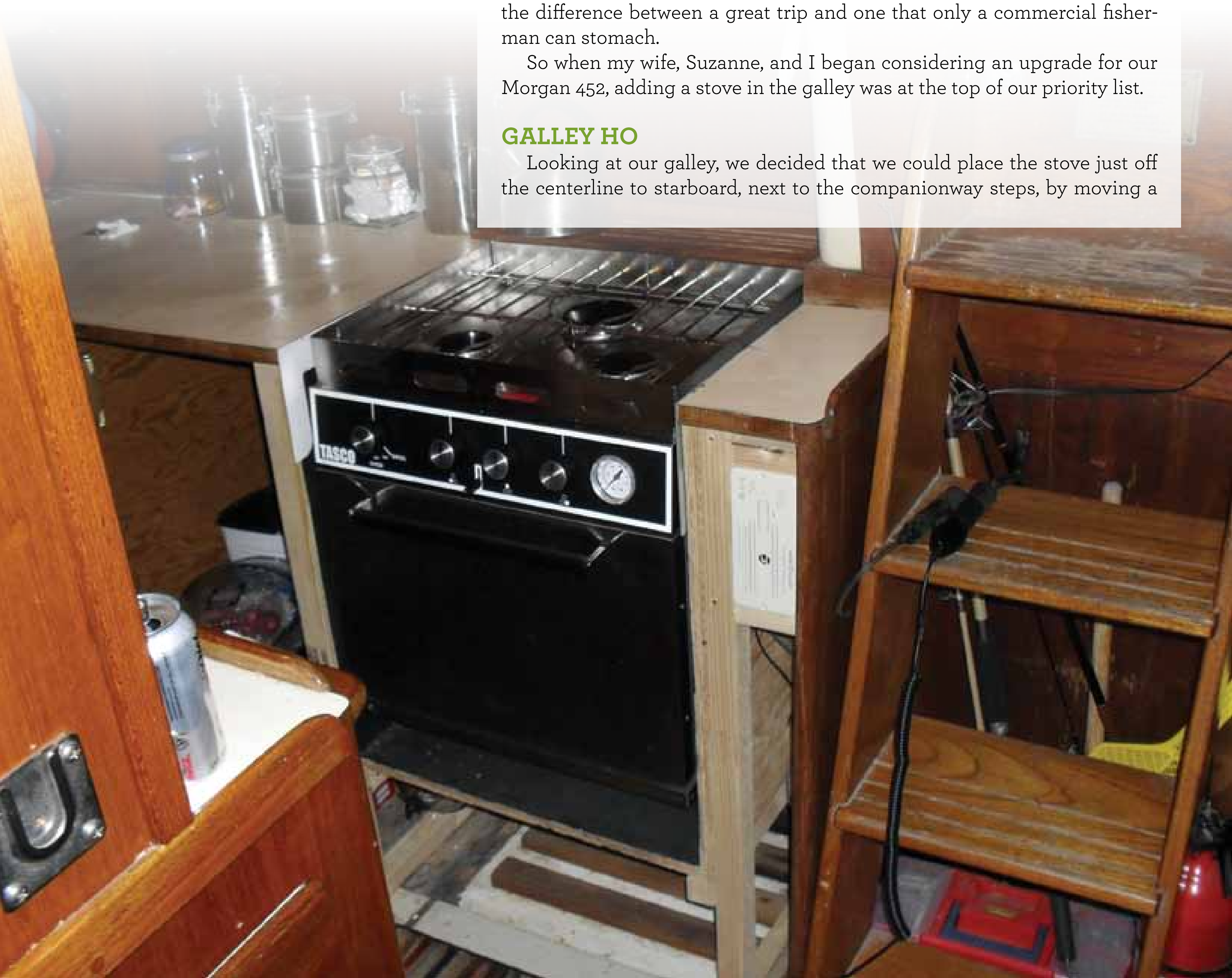
It is during a recent episode of “Deadliest Catch,” a television program about crab fishermen in the Bering Sea, that a crewman begins suffering from sleep deprivation. With no time for rest, he prepares himself a “high-energy” drink made from raw liver and eggs. As the crewman drains the glass, the narrator solemnly informs viewers that calories can help the body compensate for lost sleep.

I have never been able to get liver down, cooked or otherwise, and it’s been a long time since I ate raw eggs. But a well-prepared meal can mean the difference between a great trip and one that only a commercial fisherman can stomach.

So when my wife, Suzanne, and I began considering an upgrade for our Morgan 452, adding a stove in the galley was at the top of our priority list.

GALLEY HO

Looking at our galley, we decided that we could place the stove just off the centerline to starboard, next to the companionway steps, by moving a



set of shelves installed by a previous owner. In doing so, we would be putting the stove nearly at the center of movement for the vessel and would be giving the heat generated by cooking a direct path outside during the summer months. We would also be creating an immediate path to safety should flames flare up.

At a boat show last year, we purchased a three-burner, gimbaled propane stove from Taunton Manufacturing. Our boat had come with an electric stove and oven, which we had replaced with a Wallas diesel stove. But the cost of keeping that stove running became oppressive. So we used a two-burner camp stove and a microwave for about a year before choosing a Tasco stove and oven, which ran about $1,200. We went with a three-burner stove largely to accommodate the recent purchase of some high-grade stainless steel cookware and our desire to fit more than one saucepan or skillet on the cooktop.

Next was the purchase of 2-by-2-inch cleat stock, to build the framework, and exterior-grade plywood. Although exterior-grade plywood does not have the same structure as marine grade, it is much less expensive and, because this would be used only within the boat, I didn't need the extra security that marine grade would have provided. As part of the installation, a bulkhead that supported the center of the countertop would have to be moved about three inches outboard and a partial bulkhead would be installed on the inboard side to support the stove.

To start, I measured the countertop and determined where the new bulkheads would be located. Installing a temporary jack stand beyond the line that the new outboard bulkhead would take, I removed the shelves. With the shelves and the decorative fiddle removed, I cut the countertop with a Dremel cutting wheel, allowing me to get close to the edge of the countertop at the rear and inboard sides. Cutting the countertop released the old outboard bulkhead, and I was able to remove the screws that held the bottom of the bulkhead to the deck.

I then built a framework from the 2-by-2-inch stock to support the outer and inner bulkheads. Once the frameworks were installed, it was a simple matter to measure and cut the plywood for the bulkheads themselves. In the process, I discovered that the bulkhead's surrounding structures were not square, and it took several hours of fitting and sanding to get the final adjustments right.

After the inboard and outboard bulkheads were installed, I added a shelf that would sit just below the stove and serve as a storage area for pots and pans.

Frank Mummert

A switch with a built-in LED indicator is a safe way to know whether the propane is turned on or off.

COOKING WITH PROPANE

The next step was to add the electrical connections for the propane system. The standards set forward by the American Boat and Yacht Council (ABYC) require a separate solenoid valve in the propane system in order to cut off the flow of propane at the tanks. In addition, I wanted to install a propane leak detector. Both of these required connections to the 12-volt electrical system. I installed a terminal strip behind the oven, below the heat zone but accessible if the stove was removed, and connected it to the DC panel, powering the leak detector and solenoid.

To control the solenoid valve, the system requires an on-off switch near the oven. In most installations, this consists of a small panel with a switch and a separate red light. The light, which is lit when the power is on and the solenoid valve is open, serves as a visual reminder to shut off the gas when it isn't needed.

Rather than install a separate light, I found a switch that had a large red handle. When the switch was in the closed position, sending power to open the solenoid valve, an LED in the handle came on, causing the entire handle to glow. I mounted this switch above the stove, next to the companionway opening, at eye level. The light is glaringly obvious when it is on and provides enough light that if the house lights are off in the front end of the boat but the switch is left on, the glow is visible in the aft cabin. The switch is also large enough that, if a fire at the stove prevented reaching it, it could be opened by swatting it with a large spoon or spatula.

FINISHING THE JOB

After labeling the electrical connections, I painted the inside of the area with fire-retardant paint and sealed the top edges with a Formica end strip that, to my surprise, came close to matching the 30-year-old countertop. Next, I installed the plates in which the oven's gimbal arms would sit. To ensure the stove would sit level at anchor, I mounted one plate and then used a dowel and a spirit level to mark the second one. Once the plates were in place, we lifted the stove into po-

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Frank Mummert spent 15 years in the Navy, where he taught nuclear engineering. He is a licensed captain. Currently he teaches sailing, and for the last two years has served as an instructor for sailors trying to obtain their captain's licenses through the Mariner's School, which is headquartered in Princeton, NJ.

Safety First When Installing a Propane Locker. Or Else.

By Frank Mummert

The American Boat and Yacht Council (ABYC) has strict requirements for propane systems on boats, and for very good reason: Boats can be destroyed–and lives lost–in seconds by mishandled propane.

When I decided to add a propane stove to my boat, I converted a locker in the cockpit of my 1978 Morgan 452 ketch to store the propane bottles. In order to meet ABYC standards, the locker had to be vapor-tight from the inside of the boat, located above the waterline and constructed of corrosion-resistant material. In addition, the locker had to open from the top only, with a gasket and a latch that shuts tightly. The unit also needed a dedicated drain that leads off the boat, above the static waterline.

Our locker met the requirements for location and design, but it had a loose bottom that allowed access to the engine room. The first step was to replace it with a single piece of wood. To achieve sufficient height for the canisters, I attached the painted board to the locker's bottom and sealed everything with fiberglass and epoxy resin, followed by two coats of white paint.

I used a through-hull that had originally been intended for use with a generator as the overboard connection for the drain line. I installed a mushroom head through-hull in the bottom of the locker, sealed it with adhesive sealant, and ran a clear line from one through-hull to the other.

Next I drilled a hole for the supply hose and electrical lines for the solenoid valve to pass through. I made them as small as possible. I pulled the hose through, lifted it to the top of the hole and sealed the bottom half of the hose with a generous layer of 5200 adhesive. I lowered the hose into the sealant, but supported it slightly off the bottom of the hole to ensure that the hose did not touch the structure of the locker.

After that layer of sealant had begun to set, I pulled the electrical wires through the same hole and filled it with more 5200. I worked the wires and sealant around to ensure that the seal was complete and then let everything sit to dry for three days. After the sealant was completely set, I poured a bucket of water into the locker and watched as the water drained out of the locker and over the side, checking for any leaks. A new gasket and hasp completed the conversion.

Frank Mummert

You can install a propane locker yourself, but you'll want a qualified HVAC technician to handle the regulator/solenoid assembly.

I then installed the propane connections to the fuel line. I had a qualified heating, ventilation and air conditioning (HVAC) technician make up the regulator/solenoid assembly, with the requisite pressure gauge. I attached the regulator assembly to the side of the locker, in the area between the two bottles, and connected the fuel line and feed hoses to the appropriate ends of the regulator using propane-rated tape to seal the connections.

The HVAC technician then came out to the boat and checked all the connections and performed a pressure check, as required by the ABYC standards.

The project took two days of work (five if you count the time we had to wait for the glue, paint and fiberglass to dry). The regulator, solenoid valve and connections were the biggest expense at $120. The hasp was $45, and two propane bottles cost a total of $55. The wood, paint and glue, as well as the fiberglass supplies, were another $55. **DIY**

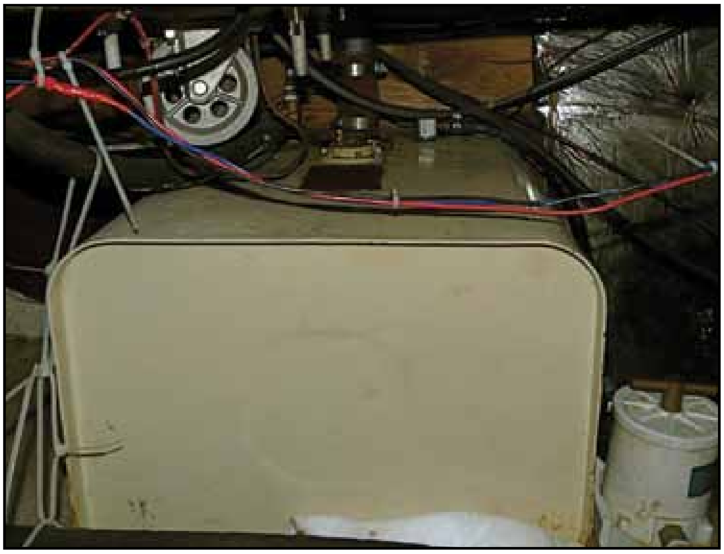
sition and connected the fuel line. (See story above for information on how we created the propane locker.)

The last step was the most important, and I wanted to test it for leaks. I covered every connection in the fuel line, from the propane bottles to the oven, with a mixture of liquid dish detergent and water. I then energized the solenoid and opened the propane valve on one of the propane tanks. The pressure gauge on the system came up and held steady. I closed the valve and started timing. While the clock was running, I inspected each soapy connection, looking for the tiniest leak. At the end of 15 minutes, I checked the pressure gauge again. It hadn't moved, indicating that the system was vapor-tight.

The project (not including the $1,200 stove) was about $180. The single biggest expense was the propane detector, which cost $95. Electrical components were $25. Wood, screws and glue were $60. The biggest investment was time. The project took two full days of work.

Although this was not the last project in the galley rebuild, it has made a big difference in the quality of our life on board.

Dinners can now include more than one hot food at a time, and the difference between cooking food on a stove and using a microwave to simply heat it is significant. I still won't eat raw eggs, but an omelet after a night watch is a welcome treat. **DIY**



photos by Chris Ferro

The only thing keeping the 26-year-old fuel tank from leaking completely was the layer of sludge built up on the bottom. The author replaced the steel model with a new one in about eight hours and a third of the cost of a professional installation.

Get Tanked

Save Big Money by Doing Your Own Fuel Tank Installation

By Chris Ferro

I first realized there was a problem when I glimpsed a sheen on the water after my bilge pump finished doing its work. I couldn't be sure if it was oil or diesel, or if the culprit was the engine or the rusty, 26-year-old fuel tank on my 1983 Seidelmann 30T.

After having the fuel polished and pumped out into a jerrycan, it was revealed that it was, indeed, the steel tank. The only thing keeping it from leaking even more was the layer of sludge on the bottom. The tank would have to be replaced.

I've done a lot of work upgrading and fixing my boat, but for some reason this project intimidated me. Only after contorting my body to fit into the lazaret, and taking a long, hard look at what was going on down there, did I begin to understand that a fuel tank isn't much more complicated than a holding or water tank.

Chris Ferro is in the midst of updating his 1983 Seidelmann 30T for another summer of cruising the Chesapeake.

Only after removal was the author able to see the extent of the rust damage to his fuel tank.

There's a fill fitting, a pickup, a sender for the fuel gauge, and the vent/fuel return fitting. How hard could it be?

OUT WITH THE OLD

The first thing I had to do was free the old tank for removal. The installation had it resting on a piece of marine plywood, up against the portside bulkhead. Strips of wood in front, behind and above it on the bulkhead kept it from moving, and a 6-inch piece of aluminum screwed down over the tank's lip on the starboard side prevented it from escaping. After I unscrewed the piece of aluminum and slid the tank out from the wooden strips, only the hoses held it in place. In my experience, hoses are the most challenging things to work with on boats, so I just cut them off and replaced them, which, by the looks of the hoses, was necessary anyway.

Because the lazaret lid was far too small for removal, the only way out was forward—over the engine. I had to saw the welded fill fitting down and then dismantle a few protruding engine parts to make room. The mixing elbow, decompression levers, breather and throttle cable, plus a few hoses and the positive bus terminal in the electrical system above the engine, all had to be removed or loosened before the tank could be squeezed out. That's when I was able to see the extent of the rust.

IN WITH THE NEW

I wanted the new tank to go in easier than the old one came out, so I searched for an off-the-shelf replacement that would be the right size. Unable to find one, I concluded that I would have to have one custom-made. I didn't want steel—I'd seen enough rust—so I considered polyethylene. But I ended up choosing epoxy-coated aluminum, mainly because I found a supplier of marine tanks that would make one more quickly and inexpensively than I could get a comparable plastic tank. Polyethylene, which never corrodes, may have been the better choice, but I was convinced that if I installed the cheaper aluminum tank properly I could at least keep corrosion at bay for a decade or so.

The American Boat and Yacht Council has standards for fuel tanks, which are worth consulting when you are buying a tank. Table IV of both ABYC standard H-33, Diesel Fuel Systems, and H-24, Gasoline Fuel Systems, lists acceptable materials for marine fuel tanks made of metal. Gasoline fuel tanks must meet also meet the U.S. Coast Guard Code of Federal Regulations requirements, though these do not apply to tanks for diesel fuel.

Unlike the old tank, which returned the fuel into the vent, the new unit has separate vent and return ports, as well as a grounding tab. I had it made skinnier and with a lower height than the old tank, so it slipped easily over the engine and into place. Because I have plenty of room behind the new tank, I had it made longer, which gave it a 14-gallon capacity instead of the old tank's 12 gallons.

The real tricks with an aluminum tank are to make sure that water cannot be trapped against the tank and that no dissimilar metals touch one another. Both can cause corrosion. In order to achieve this, I elevated the tank off the marine plywood and separated it from the port-side bulkhead with Dri-Dek, a plastic decking material that I cut to size. I then reused the same strips of wood that had secured the old tank in place on its sides, along with several small pieces of

The empty location, with hoses and the sender ground wire labeled. There's room for a slightly larger tank beyond the "diesel-stain" footprint of the old tank.

The hose clamps to the deck fill are accessed behind the engine panel. The author replaced the fitting with one that doesn't need a key.

King's Starboard to hem in the tank and prevent it from moving. To lock it down, I clamped the tank in place with a piece of oak (stained to make it resistant to water absorption), bolted to the floor with long, threaded rods and Loctite-covered wing nuts. With the wing nuts cranked tight, movement and chafe should be eliminated, though I'll check periodically just to be sure.

Later, I learned that ABYC standards call for nonabsorbent support and chocking materials, so that moisture cannot be trapped (even small amounts of moisture can cause pinhole corrosion). I will go back in at some point and replace the wood I used with more Starboard, which will be doable because the wood is external and not under the tank.

Once the tank was in place and secured, I installed the hose fittings and the hose. On metal fuel tanks, care must be taken when choosing and installing fittings to avoid the galvanic corrosion that can take place between dissimilar metals. ABYC standards H-24 and H-33 have information on how to provide proper barriers.

In addition, all flexible fuel lines should meet the permeation and fire resistance requirements of ABYC standards H-24 and H-33 (Table I in both standards). All of the hoses went on without any problem, but I had to soak the 1.5-inch fill hose in a pot of boiling water before I could jam it into place. While I was at it, I replaced the old deck fill fitting (which meant removing the engine control panel to access it).

The tank came with a sender unit, which, per the instructions, I sawed down to size and then screwed in. Hooking up the two sender wires and the ground wire to the engine was painless. All that was left to do was fill the tank, check for leaks, put the engine back together (not as bad as it sounds), bleed the air out of the system and crank it up. All went well.

The project cost about $700. The biggest expense was for the tank, sender and fittings, which, with shipping, cost about $447. Hoses and clamps were the second-largest expense at roughly $140. Additional fittings ran $45, and the deck fill fitting was $23. All-Thread, nuts, washers and wing nuts ran $20. Starboard for the job cost $33. Doing the project myself, took about eight hours after I mapped out what I planned to do (I was plotting for more than a year). The project cost about a third of what a professional would have charged. **DIY**

Boxed In

Build Your Own Custom Battery Box

By David and Zora Aiken

A neat engine room makes a happy engine owner. To that end, we built a battery box to accommodate the 12-volt starting battery and the two 6-volt batteries we use aboard our 35-foot Chris-Craft for "house" power.

While the dimensions of your box may vary, the overall size of our project measured about 3 feet long, 8.5 inches wide and 12 inches high.

A 4-by-4-foot piece of ½-inch plywood was enough to provide panels for the top, bottom, front, back, two sides and one divider. Keep in mind that your cutting pattern must account for the thickness of the wood as the box is assembled. Also, the top of the battery box should be slightly wider than the bottom—about ¼ to ½ inch—to facilitate the use of hold-down straps.

You will need a 6-foot piece of pine (1-by-1-inch or other suitable cleat stock), from which to cut one 3-foot length and two 8-inch pieces. Other materials and supplies include four 4-inch pieces of ¼-inch "batten" wood strips, 2 inches wide; fiberglass cloth (6 ounce); epoxy resin; thickener (high density); a plastic spreader; a brush; and cleaning solvent, sandpapers, primer and painting supplies.

The battery box is a good project for practicing stitch-and-glue construction, using nylon cable ties for the stitching and thickened epoxy resin for the glue. After the plywood is cut, lay out the pieces, aligning each side panel with the edge where it will attach to the bottom. For each "seam" where two panels meet, drill a series of holes through both panels at about 3-inch intervals, or as needed. Run a small cable tie through each pair of holes and tighten to draw the panels together. When all panels are clamped with your ties and the box is formed, mix thickened epoxy and spread it into each interior seam. When the epoxy dries, remove the ties; finish the seams with more thickened epoxy. Use a wooden stick to shape a neat seam that fiberglass cloth can cover. Scrape away excess epoxy.

When the epoxy dries, sand down any lumps. On the exterior, fill all the gaps in the seams; when dry, grind down the epoxy lumps and

photos by David and Zora Aiken

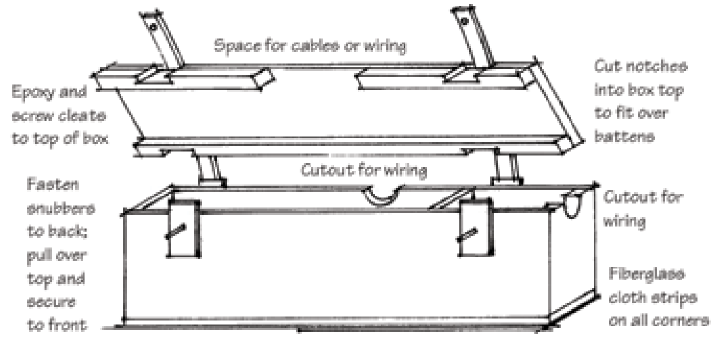
Above, the finished battery box, shown in place. **Right,** use a variation of stitch-and-glue construction to build the battery box, as shown in the top photo. Make the box watertight by filling all seams with epoxy resin thickened with a high-density filler.

David and Zora Aiken have been liveaboards for more than 20 years and are authors of Good Boatkeeping *and* Cruising: The Basics.

round the sharp corner where panel edges meet, so that the fiberglass cloth can turn around the seams. Cut strips of fiberglass cloth about 2½ to 3 inches wide to cover every seam, inside and out, and saturate them with epoxy resin.

Batteries need ventilation, so the box can't be tightly closed, but for safety, the box top needs to be held down securely. Epoxy and screw the 3-foot 1-by-1 cleat to the underside of the plywood, where the box top will meet the back. Epoxy and screw the two 8-inch pieces of 1-by-1 to the underside where they will meet the front, leaving the leftover space in the center as a place for wiring to pass. Some space will be open above the side panels, and if more is needed to lead battery cables or wiring for the battery charger, cut away a small half-circle from each side or the back. Apply fiberglass cloth to both surfaces of the box top.

One last addition to the box: four battens must be attached. Screw the battens (the strips of ¼-inch wood, 2 inches wide) onto the outside of the box, two on the front and two on the back. They should be positioned about 6 inches from each side, and they should extend above the front and back panels to match the level of the box's top. Notch the top where it will meet these battens; that will prevent the top from slipping sideways when the hold-downs are in place.



David Aiken

Schematic of the battery box. Most boaters can use materials in their dock box; from scratch the project should cost no more than $130.

When construction and fiberglass work are complete, sand, prime and paint the box. Consider mixing nonskid into the paint for use on the top if the box can be used as a foot brace for someone working in the engine room. Or you could use nonskid tape.

Check the intended location of the box to see if it needs to be leveled or supported to prevent shifting. This could be done by applying fiberglass wedges to the hull, or using L-shaped brackets if practical. On our boat, the box rests against—and is screwed into—the engine bed.

The top of the battery box must be secured so no amount of pitching or heeling will dislodge it. For this, use two black rubber snubbers, the kind that are purchased with an S-hook at each end. Remove the S-hook; this will leave a hole in the rubber where the exposed end of a machine screw will fit. For each back batten, run a 1¼-inch machine screw (Phillips pan head) from inside the box; place the snubber on the screw and secure it with a washer and nut. For each front batten, run the machine screw from inside the box, and tighten it with a nut. Then pull the rubber snubber over the top and place the end onto the machine screw on the front batten. Add a wing nut for insurance. The snubbers will put enough pressure on the battens to keep them wedged in the notches.

A project like this will likely utilize a lot of materials already in your dock box: leftover resin, small pieces of cloth and paints, just to name a few. However, if you need to start from scratch, materials and supplies would run you about $130. It will take about 15 hours of labor to do the job and some additional sitting around time while you wait for the epoxy to dry between steps. **DIY**

Fill and apply fiberglass to all seams on the exterior of the box.

The Ugly Duckling

Don't Let Rundown Cabinets Sour Your Galley. Rebuild Them.

By Graham Collins

Thanks to years of water damage from a leaking window and badly located doors, and a generally rundown appearance, the cabinets on our Aloha 27 were overdue for replacement.

This was a winter project, which I began before wrapping the boat by removing the old cabinet faces and cleaning the hull liner where the cabinets were extracted.

In my arsenal of tools for the job were a table saw, sander and drill press. Optional but useful tools included a router or Rotozip and thickness planer. I purchased ¼-inch marine-grade teak plywood to fashion the cabinet faces and door panels. I also needed 1-by-2-inch solid teak lumber to make door frames and doors, as well as a selection of hinges and latches.

Graham Collins

Before and After: The author rebuilt his old cabinets, above, with new ones made from teak, top.

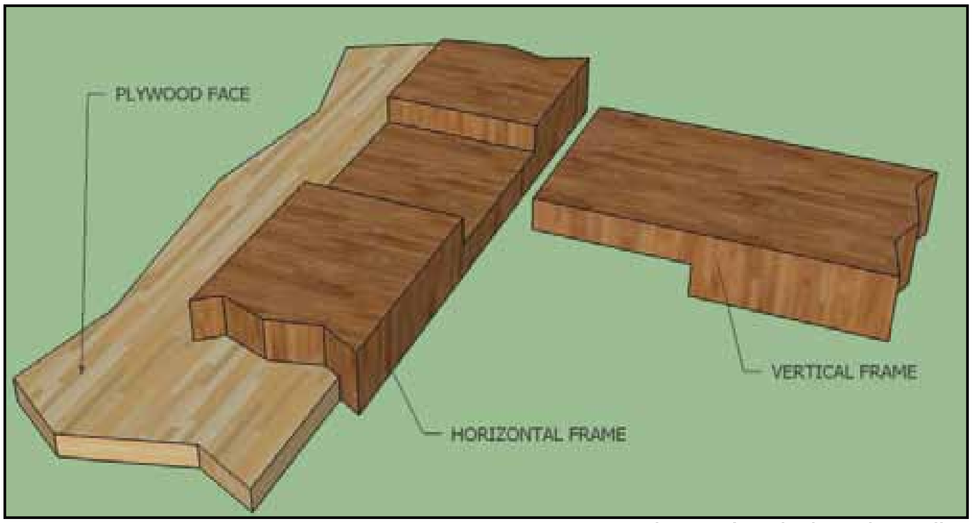
MAKING THE CUT

I began by cutting the new faces, using the old faces as a template. I measured carefully and made the cuts in a way that minimized splintering. My favorite method is to rough-cut with a jigsaw and then trim to fit. I like to use a Rotozip or router with a guide and a bearing bit to create a smooth and straight edge, a requirement when insetting the door frames later in the project.

Once I cut the faces, I gave them a test fit (again, before the boat was wrapped). My installation involved moving the doors from their original location. Once the new site was decided, I marked the face where it would be cut. My design used a glued-in frame made of solid teak. The width of the frame reduced the cutout opening by ¼ inch, and the dimensions of the cutout were enlarged accordingly.

First I did a rough-cut of the opening with a jigsaw and then used a Rotozip with a flush-cut bit and a guide

Graham Collins, an engineer by trade, has run out of projects for his Aloha 27, Tardis, and is now making a project list for the C&C 35. He sails the waters near Halifax with wife Jill and son Sam.



photos and graphic by Graham Collins

Clockwise from top: The frame edges are mortised into the plywood frame and notched for greater support in the vertical frame. Glueing the horizontal frames into place. Make sure to "dry fit" the door pieces and face sections before permanently installing.

to clean up the opening.

Each opening has a frame glued in for reinforcement, which also covers the exposed plywood edge. I made the frame with 1-by-¾-inch wood, which offered a ¼-inch lip to cover the plywood edge. The frames also include vertical pieces where the doors meet.

Each piece of the frame extends about an inch past the edge of the cutout, so our 10½-inch-square cutout would require frame pieces that were 12½ inches long and would result in an opening that measures 10 inches square. I first fit the horizontal pieces of the frame by trimming away 1 inch of the lip on one end and marking and trimming the lip on the other end so that the lips fit within the cutout. Then I cut notches in the back of the pieces to fit the vertical pieces of the frame.

The horizontal pieces were then glued to the back of the cabinet face with epoxy. The vertical pieces were fitted next and glued in place. The vertical pieces are mated to the horizontal pieces using lap joints.

THE DOORS

The doors were constructed of a plywood panel, surrounded by a solid frame that is 2 inches wide. In cabinet lingo, the vertical pieces are the stiles and the horizontal pieces are rails. Starting with 2-inch wide stock, I cut the stiles about ¾ of an inch longer than the vertical dimension of the opening (so that when closed, the door will cover the face of the frame). At this point, I test fit the hardware I used on one set of stiles, which ensured I was sizing the rails correctly.

With the stiles lined up, I measured the distance between them. Adding ¾ inch to this dimension, I cut the rails to length. Next I cut grooves for the plywood panel. Using a table saw (you could also use a router), I cut a ¼-inch-wide groove down the center of one edge of each rail and stile. The groove was ⅜-inch deep. Before you do this, it's best to look at each piece and decide if one face is better than the other.

The final cuts are were for the so-called tenons. A tenon is a stub of material that will protrude into a mating cutout, adding strength to a joint. In this case I was mating the rail's tenon into the groove on the stile. The stub has to be just a touch shorter than the depth of the groove.

Using the plywood cut from the cabinet face, it was time to cut out the door panels. They should be as long as the rails, minus ⅛ inch, and as high as the stiles, minus 3 ⅜ inches. This will leave the panel ⅛-inch smaller so it won't interfere with assembly of the door.

Before assembling the doors, there are two important steps. The first is to sand and apply a coat of finish to each panel. This will ensure that the panel has a nice look, even if it shifts about in the frame and exposes an area that was covered during assembly. You must also sand the side of the stiles and rails where the groove is cut, because this will be much more difficult to reach once the panel is installed. With my prep work done, it was time to mix up some epoxy and glue up the door.

The last step was to fit the hardware. I used regular cupboard hinges and locking latches. The latches I used lock when pressed in, and when popped out they act as a handle. I fitted the hardware to the doors and then removed the hardware before finishing the wood. After sanding, I applied several coats of varnish. Then I was ready to install the new cabinets in the boat.

The first stage of installation was to attach the cabinet faces to the boat. To that end, the top of each cabinet face was fitted into a groove in the headliner. The bottom was then fastened to a thin strip of wood that screwed down at the front of the shelf.

With the doors mounted, I was finished. The project was time-consuming, about 60 hours in all, but the cost was reasonable at about $740. The largest expense was the wood, which cost $390. The latches were $180, and the hinges cost $63. The new doors make the boat look considerably better. An added bonus: They allow much better access to the storage space. DIY

Success Stories

It Took Family Teamwork and a Lot of Sweat to Give One J/24 New Life

When David Marshall, 21, heard the siren song of a beat-up J/24 last year, he was instantly hooked.

While he knew his father, a boat designer and writer by trade, might object to the time and sweat required to fix the vintage heap, he figured the restoration would be an irresistible family project. And a project it was: The cabin sole had delaminated, the bilge was watery, the gel coat was faded and dinged, and the boat-speed impeller had been yanked and covered with a skim coat of fiberglass. What did they find serving as a through-hull stopper? A champagne cork, of course.

And so the challenge was on to transform the boat from a wreck to a racer. Over the winter break, David, his dad, Roger, and his brother, Mike, stripped the boat down to its keel, removing much of the 1979-era gear and upgrading with a full kit of Ronstan Orbit blocks and cleaning the winches.

They stripped out the rotted plywood floors, replacing them with closed-cell, high-density foam, and sanded the hull clean. After the agonizing job of prepping the topsides for paint, using more sandpaper than anyone imagined possible and applying primer, a final topside spraying was handled by Jamestown Boatyard in Rhode Island. After the boys returned to college, Roger replaced the foredeck and main companionway hatches.

They finished by painting the interior, installing a new cabin sole, doing some electrical work, rewiring the lights and installing new LEDs inside and out in place of existing halogen bulbs.

The job was big, taking 16 months of work on and off. Because Roger was able to swing some sponsorships (Ronstan and Interlux, as well as some help from the boatyard) to defray costs, he says the job was done for just under $3,000 (versus the $10,000 they would have spent to purchase all new gear and have the work done by pros). About 20 to 25 percent of the costs were for disposables, such as grinding discs, sandpaper, Tyvek suits, rollers and brushes; about 25 to 30 percent went into materials such as fiberglass, resin, foam and paint. New equipment accounted for the balance.

–Leef Smith Barnes

Photos by Roger Marshall

Successes are worth sharing.

Whether you're knee-deep in renovating an old boat or you've just finished building one from scratch, we'd like to hear about it. Drop us an e-mail with a before and after picture and a 200-word-or-less description of your work at LeefSmithBarnes@Diy-Boat.com. *If we publish your story, we'll give you a one-year subscription to DIY Boat Owner.*

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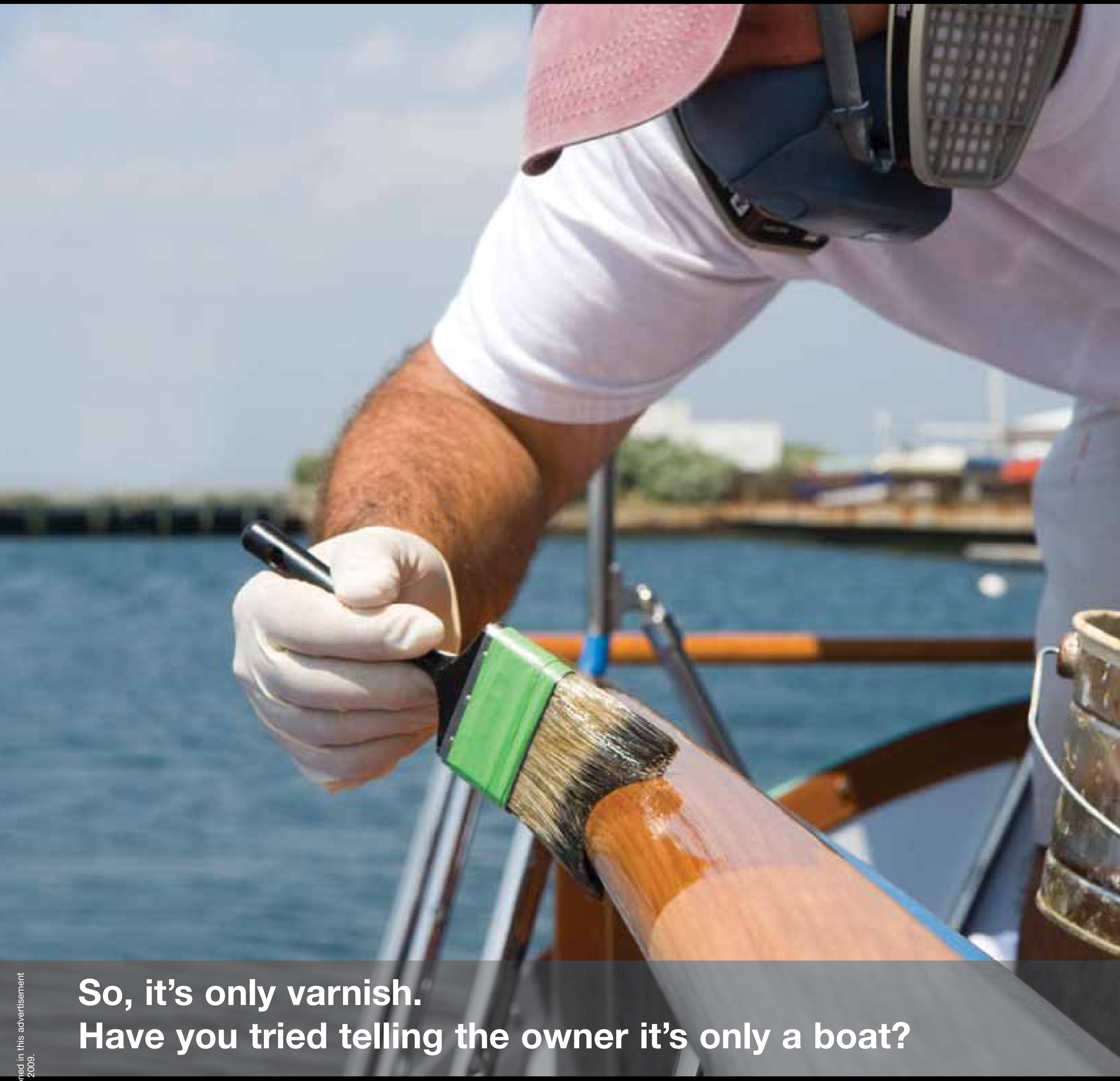

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