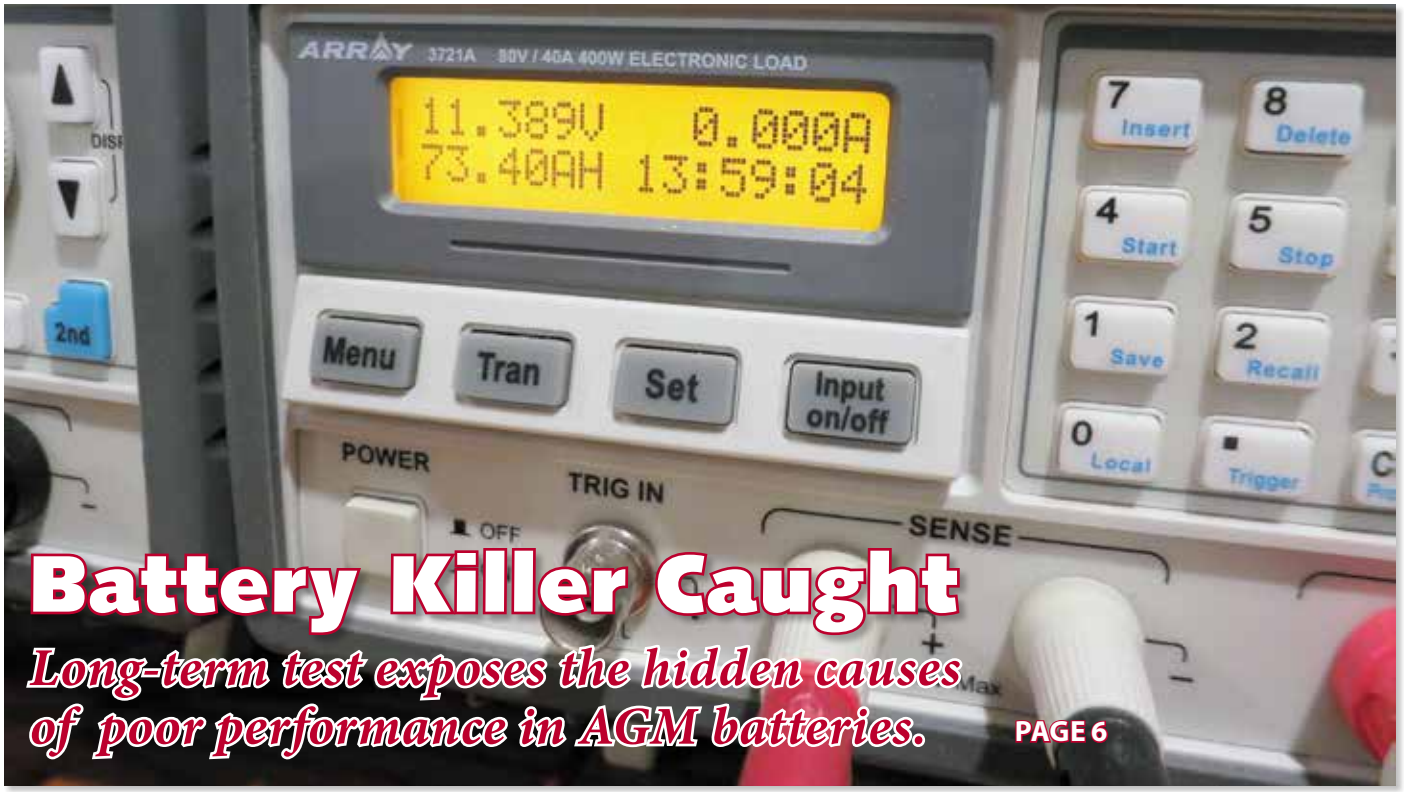
VOL. 41 NO. 5 MAY 2015

Practical Sailor™



Battery Killer Caught

Long-term test exposes the hidden causes of poor performance in AGM batteries.

PAGE 6

PAGE 14

PAGE 22

PAGE 26

$7.50US
05>
0 74470 26832 1

ALSO IN THIS ISSUE

The backstay toggle on a Hawaiian day charter boat reflects a dangerous lack of professionalism.

Photo by John Koon

Rig Tips that You Can Use

This issue of *Practical Sailor* offers a wake-up call for owners of sailboats with rigs of an indeterminate age. But it also offers some hope. Over the years, we've published a variety of articles on the hidden risks of stainless-steel hardware—chainplates, tangs, toggles, clevis pins, etc.—important bits that keep a rig from coming down.

Probably the most detailed article on the topic was Technical Editor Ralph Naranjo's critique of stainless steel (see *Practical Sailor*, February 2007 online). *PS* writer Patrick Childress concentrated on chainplate problems, which were the cause behind his mid-Pacific rig failure (see *PS*, December 2011 online). And various installments of Mailport and *PS* Advisor have featured readers' experiences with failed hardware such as snap shackles (see *PS* Mailport, April 2010 online) and questions regarding rigging replacement and inspection schedules (see *PS* Advisor, January 2010 online).

One underlying moral of these stories is that stainless steel can fail without warning, a message that can leave a boat owner feeling helpless. Does this mean that our only resort is to replace anything that raises suspicion? The line between caution and paranoia becomes thin.

Fortunately, stainless-steel hardware has a long and mostly successful track record on boats, and the warning signs are often apparent. The trick is knowing what to look for when purchasing new gear, and how to inspect what we already own.

This month, renowned rigger and author Brion Toss puts a philosophical spin on spotting potential rig trouble (see "Hidden Causes of Rig Failure," page 22). Although he is quick to say some problems can be traced to poor installation guidelines or shoddy manufacturing practices, he also reminds us that most rig problems are due to our own failure to educate ourselves on some of the basic principles of rig maintenance and inspection.

Boat owners can turn to a number of helpful resources that will guide them through an inspection to ensure that their rigs are up to snuff. If your boat was built in the last decade or so, chances are good that the boat manufacturer, or the spar company contracted to supply the rig, includes maintenance and inspection guidance.

For owners of older boats, owners' associations can be a vital source. Websites or message boards dedicated to Taiwan builders such as Hans Christian, Ta Chiao (Formosa, Island Traders, CT) and Tayana, as well as many U.S.-built boats (like Childress's Valiant 40) have documented a range of chainplate problems and repairs in detail. Some of these problems are quite obvious, and will usually turn up in a routine visual inspection—others are not. (Google-search your boat model, for example "Tayana 37 chainplate," to see what sort of rig issues your boat might have.)

The U.S. Coast Guard Marine Safety Alert, "Sailboat Rigging Dangers," published in 2009 (*www.mxak.org/uscg/uscg_pdfs/7-09a.pdf*), has links to a couple of helpful websites. The alert, which was issued after a spate of rigging failures on Coast Guard-certified charter catamarans, should be required reading for every sailor, whether he has questions about the integrity of his rig or not.

If you have rig questions or failures to report, send them to practicalsailor@belvoirpubs.com. That's why we're here.

After 30 partial charging cycles, the Deka battery topped out at just over 73 amp hours on our capacity tester. (Photo by Rod Collins)

Practical Sailor

May 2015 • Vol 41 No 5

EDITOR
DARRELL NICHOLSON

MANAGING EDITOR
ANN KEY

TECHNICAL EDITOR
RALPH J. NARANJO

CONTRIBUTORS
KEN DELAVIGNE, RON DWELLE, DREW FRYE, DAVID GILL, DAVID LISCIO, FRANK LANIER, THERESA NICHOLSON, JONATHAN NEEVES

EDITORS AT LARGE
DAN DICKISON, NICK NICHOLSON, DOUG LOGAN, DAN SPURR

CREATIVE DIRECTOR
JUDI CROUSE

PUBLISHER
TIMOTHY H. COLE

EDITORIAL OFFICES
7820 Holiday Drive South, Suite 315
Sarasota, FL 34231
practicalsailor@belvoirpubs.com

CUSTOMER SERVICE, WEB, BACK ISSUES, or FAX SERVICE
PO Box 5656
Norwalk, CT 06856-5656
800/424-7887
customer_service@belvoir.com

SUBSCRIPTION DEPARTMENT
800/829-9087
www.practical-sailor.com/customer_service/
Box 8535, Big Sandy, TX 75755-8535
For Canada: Box 7820 STN Main, London, Ontario N5Y 5W1

Belvoir

Practical Sailor (ISSN #0161-8059) is published monthly by Belvoir Publications Inc., 535 Connecticut Ave, Norwalk, CT 06854-1713. Robert Englander, Chairman and CEO; Timothy H. Cole, Executive Vice President, Editorial Director; Philip L. Penny, Chief Operating Officer; Greg King, Executive Vice President, Marketing Director; Ron Goldberg, Chief Financial Officer; Tom Canfield, Vice President, Circulation. Periodicals. Postage paid at Norwalk, CT, and at additional mailing offices.

Subscriptions: $84 annually. Single copies, $7.50 (U.S.). Bulk rate subscriptions for organizations and educational institutions are available upon request.

Postmaster: send address corrections to PO Box 8535, Big Sandy, TX 75755-8535. Practical Sailor, P.O. Box 39, Norwich ON, N0J 1P0 Canada. WDS return address in Canada: Station A, P.O. Box 54, Windsor, Ontario N9A 6J5.

REPRINTS FOR PUBLICATION AND WEB POSTING AVAILABLE
Contact Jennifer Jimolka, Belvoir Media, 203/857-3144

PRACTICAL SAILOR ACCEPTS NO COMMERCIAL ADVERTISING

ANTI-BIRD CAULK

In regard to your March 23, 2015 blog on bird deterrents: I moved to Florida a few years ago and was the only sailboat in a 20-slip location. Little black birds infested it right away. I tried flying owls, kites, balloons, sitting owls, snakes, etc., and nothing worked for long. Those little black birds would sit on top of my Windex and spin around, and poop all over the boat.

I finally solved the problem. No bird has set foot on my mast or spreaders since I got a product from Home Depot called "Bird-X" (*www.bird-x.com*). It is in a caulk tube and applied with a caulk gun; it does not get hard but remains sticky. The birds hate it. A thin line of Bird-X caulk on top of the Windex stopped all birds from lighting up there and everywhere else up the mast. It has been two years, and I have not had to re-apply.

Aubrey Laughlin
Nellie Belle, 1967 C&C Corvette 31
Fairhope, Ala.

The only solution that reader Aubrey Laughlin found to keep birds from "decorating" the boat's new PlasDeck synthetic teak deck and black Sunbrella sail cover was Bird-X caulk.

SONIC BIRD CONTROL

Even if you achieve some initial success, birds will usually get used to the deterrent after a while. But what I've learned is: 1) You have to know what birds you're fighting; 2) You have to learn what they're afraid of; and 3) Whatever deterrent(s) you deploy must change frequently.

For gulls, I've had some success with simply arranging black dock lines to look like snakes. For ospreys, creating a nearby nesting platform on a pole, if possible, is the most effective deterrent because osprey nesting pairs won't set up camp near another nesting pair. But starlings tend to be the problem—hundreds park themselves all over the boat and trash it in minutes with red berry poop—so I try to remove everything I can during the lay-up season. I've also tried covering the boat with tarps, but windstorms play havoc with them.

I've found the BirdXPeller Pro (Bird-X BXP-PRO 1; *www.bird-x.com*; $135 on Amazon) to be very effective with the right predators, maximum volume, and random/long delay activations during daylight hours only. Another advantage of this unit is that it also repels annoying people.

Glenwood Coombs,
Dream Seeker, Lagoon 380
Solomons, Md.

BirdXPeller Pro

TEAK DECK SEALER

Is T-Jett Teak Wonder (*www.teakwonder.co.uk*) available in the USA?

Michael McCarron
Hana Hoi, Mainship 30 RR
Punta Gorda, Fla.

Teak Wonder is distributed in the U.S. by Scandvik Inc. (*www.scandvik.com*), and it is available through U.S. online retailers like Defender, Jamestown Distributors, and Fisheries Supply. Chandlers that stock it include Sailorman, Budget Marine, and National Marine.

We've heard good things about it from local boatbuilders, so we will be including Teak Wonder in our upcoming long-term test of wood finishes and deck sealers.

ELUSIVE INDEX

The "Clarification" section in the February 2015 issue says the "online version" of the 2014 article index is correct. Can you tell me where to find it?

Bill Rightor
Via email

Starting from the Resources section (on the bottom right-hand side of the *www.practical-sailor.com* homepage), you can locate the index two different ways:

Photos courtesy of Aubrey Laughlin and manufacturers

Sails and Spring Cleaning

As the Northern Hemisphere shakes off winter and spring-cleaning gets underway, many sailors are busy with system upgrades, do-it-yourself projects, and the usual marine maintenance fun. Here are some archive articles we think will help you tick off the tasks on your to-do list.

SAILS & HARDWARE

In the market for a new mainsail or hardware? Check out the August 2011 article on how to choose a new cruising main and the June 2013 review of mainsheet tackle. For hardware seekers, we recommend the test reports on ratchet blocks (May 2009), snatch blocks (August 2008 and August 2007), and rope clutches (March 2009, June 2009, and November 2014). You'll find these articles and more in our three-part ebook series, "A Look at Sails," which is available in our online bookstore at *www.practical-sailor.com*.

Stay tuned for our upcoming reviews of roller-furling genoas and stanchion-mounted furling fairleads in future issues.

DO-IT-YOURSELF

For the DIYer, we have a slew of possible spring projects worthy of your time. Cruisers will want to look into the trysail-track refit report (May 2012) and the blog post on how to build your own custom medical kit (*Inside Practical Sailor*, June 12, 2014; July 2014 *PS* issue).

For the maintenance-minded, there's a comprehensive look at gelcoat restoration (*Inside Practical Sailor* blog, June 30, 2014) and articles on DIY blister repair (February 2011) and redoing your teak decks (June 2011).

MAINTENANCE

Wondering what the best products are for those spring-summer cleaning jobs? Be sure to read our test reports on boat soaps (January 2013), waterline stain removers (April 2014 and November 2007), isinglass/clear-vinyl cleaners and protectors (May 2014 and March 2009), and hull waxes and polishes (*Inside Practical Sailor* blog April 9, 2014 and July 2014 *PS* issue).

NEW EBOOK

Our latest ebook is now available. "Volume 1, Anchoring in Sand and Mud," is the first in a multi-part ebook series that offers over 15 years of anchor test reports in one publication. Look for it in our online bookstore.

1) Click on the "Practical Sailor 2014 Index" link, or

2) Click on the "Archives" link, select the December 2014 issue, and then click the "Download this issue" link located just to the right of the issue name. The index is on page 31.

CRUISERS' TACKLE BOX

We are trying to buy the last tackle box we will ever need. We were hoping to find one made of aluminum, but everything seems to be made of plastic these days, not something that would survive the cruising lifestyle. My best idea so far is to buy a tough, steel, cantilever toolbox and give it a good coat of Rustoleum.

Nathaniel Montague
Via email

Large, rigid tackle boxes are a headache to stow. Plus the plastic ones are susceptible to UV degradation and weathering, and metal ones are likely to rust. If you insist on a hard case, check out Pelican (*www.pelican.com*), whose rugged cases (like the 1460) can be customized for fishing tackle and have done well in our tests.

However, we recommend using a large, easy-to-stow, soft-sided tackle bag like those made by BlackTip (i.e. product No. BGDF0297; *www.west-marine.com*). You can fill it with the clear, divided Plano Stowaway utility boxes (*www.planostoragesolutions.com*), which make it easy to organize and neatly stow your tackle (one box for offshore rigs, another for inshore, etc.), and they make the gear easy to access; just label the clear plastic box with a Sharpie, and no more digging for what you need.

DURABAK FIELD REPORT

Based on *PS*'s test results (see *PS* January 2012 and November 2013 online), I refinished my nonskid using the Durabak white textured-UV product in 2014. I followed the instructions scrupulously, applying two coats after careful preparation.

I was originally very happy with the outcome. The nonskid is very

Photos by Ralph Naranjo

RECALLED FIRE EXTINGUISHERS

Spring is a good time to check your fire extinguishers to be sure they haven't expired, but if you own a Kidde extinguisher, you'll want to also be sure yours wasn't part of the company's recent recall. Well-known fire extinguisher manufacturer, Kidde, in conjunction with the U.S. Consumer Product Safety Commission (CPSC), announced a voluntary recall to replace certain Kidde fire extinguisher units, according to Boat Owners Association of the United States (BoatUS).

Kidde launched the recall in response to cases of some extinguishers having faulty valve components that can cause the disposable fire extinguishers to not fully discharge when the lever is repeatedly pressed and released. BoatUS said that about 4.6 million extinguishers have been recalled; these were sold nationwide between August 2013 and November 2014. This includes 31 different models of Kidde extinguishers. The extinguishers are red, white, or silver with black plastic valves and are ABC or BC rated and manufactured in Mexico between July 23, 2013 and Oct. 15, 2014, BoatUS reported. Some of the affected extinguisher models were designed for the boating market and have a nameplate on the front with the names Mariner 10, Mariner 110, Mariner 5, and Mariner 5 G.

According to BoatUS, citing the CPSC, Kidde received 11 reports of fire extinguishers that failed to discharge, but no injuries have been reported. Apparently, the problem arose from a production issue that has since been resolved.

To find out whether you have an affected fire extinguisher and arrange for a replacement, go to *www.cpsc.gov/en/Recalls/2015/Kidde-Recalls-Disposable-Plastic-Fire-Extinguishers*.

aggressive, which is exactly what I wanted. For the first few weeks, the paint was very white, but the brightness dulled a little bit to a very pleasant-looking light gray.

Last fall, I noticed that the paint seemed to be decomposing. Flakes started to come off, both from standing on it and when I washed it with a garden hose and very soft deck brush. This left white specks all over the place. The flakes are separating from the paint; it is not that the paint is separating from the substrate.

I contacted the Durabak distributor (*www.durabakcompany.com*) and the manufacturer (Cote-L). I sent them paint chips, and their analysis showed that it is not an adhesion problem (so it is unlikely to be caused by faulty application), but that, for an unknown reason, the second (top layer) is separating from the first. Also, the change of color that I had observed was not supposed to happen. Neither Durabak nor Cote-L can explain what caused this color change. Their recommendation is to clean the surface and apply two additional coats of the same material.

Ernst Niebur
Columbia 32
Baltimore, Md.

Another reader's letter, which we published in the March 2012 Mailport, also reported an issue with Durabak's color fading. Our Durabak long-term test panel has shown no signs of fading or flaking, and it's been in the Florida weather for the better part of 2½ years. The Durabak that we applied to the Chesapeake Bay-based Union 36 *PS* test boat in 2011 also is holding up well to weather and wear.

Durabak told us that they did not know what might cause these problems and that the flaking you describe was the first example they'd seen. Although Durabak was certain it was not a case of a bad batch of paint, they've offered a replacement product at no charge.

CLARIFICATIONS

The maker of the KISS-SSB Grounding System (counterpoise) did not tell *Practical Sailor* that its product will not work as designed with the GAM-McKim Split Lead Antenna, as implied in the December 2014 *Rhumb Lines* column. Further clarification appears in the online version of that editorial.

The article on remote oil filters that appeared in the February 2015 issue included a statement regarding the risks of a remote filter causing a drop in oil pressure, if it is mounted high above the engine. In short, boat owners should consult their engine manufacturer before modifying their boat's oil circulation and filter system. And, as with a stock oil system, you should always check oil pressure immediately after changing oil. A more detailed explanation appears in the online version of the original article.

Blue Water Paints' Gold Coast SPC is an ablative paint. It was mistakenly listed among hard paints in the Value Guide on page 9 of the April 2015 issue. The online version of the table has been corrected.

Practical Sailor welcomes reader comments and questions. Send email to *practicalsailor@belvoirpubs.com*; include your name, homeport, boat type, and boat name. Send Gear Graveyard samples to PS at 7820 Holiday Dr. S., Suite 315, Sarasota, FL 34231.

Photo courtesy of Ernst Niebur

Reader Ernst Niebur was disappointed to find that his Durabak nonskid began to fade and breakdown (right) within one year of application.

Rod Collins, of Compass Marine, checks out equipment during testing, which kept him occupied through most of Maine's winter.

Fighting Sulfation in AGMs

PS *explores why our batteries don't last as long as we had hoped.*

In recent years, the popularity of absorbed glass mat (AGM) batteries has soared, yet few owners truly know how to take care of them. If you want to get your money's worth out of a new AGM battery or battery bank, it should be installed as a system—not simply dropped in as a replacement for flooded batteries .

Battery manufacturers want their batteries recharged to 100-percent state of charge after each discharge. In reality, few cruising boats (or any boats kept on a mooring) return their batteries to 100-percent state of charge after each cycle. This typical battery use, or abuse, is called partial state of charge operation, and if it continues, a sailor can see his AGM battery perform noticeably worse than a less costly, deep-cycle flooded battery bank. This isn't the battery's fault; it is just a lack of understanding of how to properly care for an AGM battery.

An often-overlooked ingredient in lead-acid battery care is equalization charging, which should be carried out periodically according to the manufacturer's recommendations. During equalization, you apply a higher than normal charge voltage (15.2 volts to 16 volts) to a fully charged battery. Equalization can restore some lost capacity and also can serve to bring the individual cells to a better balanced specific gravity. In a 2008 *Practical Sailor* article, veteran cruiser Andy O'Grady described how he used equalization to prolong the life of his heavily used wet-cell batteries (see *PS* October 2008 online).

Generally, equalizing an AGM battery is more complicated than it is with a flooded lead-acid battery (many AGM makers don't even provide guidance on how to do this), so attaining 100-percent state of charge after each cycle becomes even more critical.

Last winter, we set out to try to solve the puzzle of AGM use and charging and to present a clearer picture of the permanent damage we are doing to our AGM batteries by keeping them in a partial state of charge. We chose AGM batteries for several reasons, but the main one was admittedly self-serving: They are easier to test.

WHY AGM?

AGM batteries are lead-acid batteries. The chief difference is that they are valve-regulated batteries, in which the electrolyte is "sealed," as opposed to wet-cell lead-acid batteries, which require you to maintain the proper electrolyte levels as the batteries are cycled. This reduced maintenance is one of the main reasons that AGM batteries are so popular.

The first step to testing a deep-cycle battery is confirming capacity. Battery capacity is measured in various ways: reserve capacity, cold cranking amps, and amp hours. We used amp hours, the most useful measure for comparing deep-cycle, "house" batteries meant for use on an average cruising boat.

In the U.S., amp hours are stated at the C20 rate, the constant rate of amperage that a battery can deliver for 20 hours, at 77 to 80 degrees, before the loaded terminal voltage falls to 10.5 volts (or 1.75 volts per cell). So, to roughly check whether your *fully charged* 100-amp hour battery meets its rated C20 capacity, you can apply a 5-amp load (100 ÷ 20), and stop when the cells reach 10.5 volts. You should get close to 20 hours. (See "How We Tested" for a deeper explanation of determining capacity.)

Notice we said *fully charged*. In order to reach rated capacity, a lead-acid battery must be cycled several times and fully recharged. In addition, to fully recharge a lead-acid battery, more energy must be returned to the battery than was removed. For AGM batteries, this may range from 102 percent to as much as 115 percent of the removed energy being returned. As a battery approaches full

Photos by Rod Collins

PS VALUE GUIDE GROUP 31 MARINE BATTERIES

MANUFACTURER	DEKA	FIREFLY	ODYSSEY	LIFELINE	LIFEPO4
MODEL	8A31DTM	FF12HR1-G31	PC2150 ✓	GPL-31T ✓	CALB SE100AHA Cells X 4
PRICE / WARRANTY*	$260 / 12 months	$425 / 48 months	$350 / 48 months	$325 / 60 months	NA**
BCI GROUP SIZE	31	31	31	31	Non standard
STATED Ah CAPACITY @ 20 HOUR RATE (C)	105 Ah	110 Ah	100 Ah	105 Ah	100Ah @ 30A (.3C)
STATED RESERVE CAPACITY @ 25 AMP DISCHARGE RATE	200 minutes	240 minutes	205 minutes	195 minutes	N/A
ABSORPTION VOLTAGE	14.4 to 14.6 volts	14.2 to 14.4 volts	14.4 to 14.7 volts	14.2 to 14.4 volts	13.8 to 14.0 volts
MARINE CRANKING AMPS @ 32 DEGREES	1000 amps	850 amps	1,370 amps	750 amps	Not rated
COLD CRANKING AMPS @ 0 DEGREES	800 amps	750 amps	1150 amps	600 amps	Not rated
WEIGHT	69 lbs.	70 lbs.	77.8 lbs.	64 lbs.	28 lbs.
DIMENSIONS (L x W x H)	13 x 6.7 x 9.4 inches	13.4 x 6.7 x 9.4 inches	13 x 6.8 x 9.4 inches	12.9 x 6.7 x 9.3 inches	10.6 x 5.6 x 8.5 inches
TERMINAL TYPE	Stud & lead post	Bolt	Stud	Bolt & brass post	Bolt
TEST RESULTS					
BASELINE CAPACITY	104.5 Ah	110.02 Ah	105.8 Ah	105.2 Ah	101.2 Ah
Ah CAPACITY AFTER 30 PSOC CYCLES	73.4 Ah	110.51 Ah	98.96 Ah	93.02 Ah	101.3 Ah
Ah SPREAD OVER 30 PSOC CYCLES	-9.95 Ah	-14.65 Ah	-9.93 Ah	-14.03 Ah	-0.7 Ah

✓ Recommended *Pro-rated after first or second year; some rebranded Dekas offer longer terms. **Varies widely by application and vendor.

charge, the number of amps it can accept tapers off. Short of counting how many amp hours you returned to the battery, an easy way to determine when an AGM battery is full is when the charge current at *absorption voltage* falls to 0.5 percent or less of the rated 20-hour capacity.

Notice we said *absorption voltage*. In order to reach a state of full charge efficiently, a multi-stage charging system is essential. The technical manual of the Lifeline battery we tested sums the multi-stage charging process this way: "In the first stage, a constant current is applied until the battery voltage reaches a pre-set limit. The first stage is often called the *bulk charging stage*. In the second stage, the voltage is held constant at the same pre-set limit until the charging current tapers to a very low value, at which point, the battery is fully charged. The second stage is often called the *absorption charging stage* . . . The battery is fully charged when the current drops below 0.5 percent of the battery's rated capacity (0.5 amps for a 100-Ah battery). If the recharge does not return 102 to 110 percent of the discharged capacity, the battery's state of charge will gradually walk down as it is cycled, leading to premature failure. Therefore, it is important to verify that the battery is not being undercharged."

An AGM battery can cycle up to its maximum rated amp-hour capacity quickly, usually in just in three to seven cycles. This makes life easy for testers.

Flooded batteries, depending upon type, can take 20 to 150 or more cycles before they reach the factory-rated amp-hour capacity. Because flooded batteries take so long to cycle up to capacity, this makes testing them very difficult, and extremely time consuming.

FIGHTING SULFATION

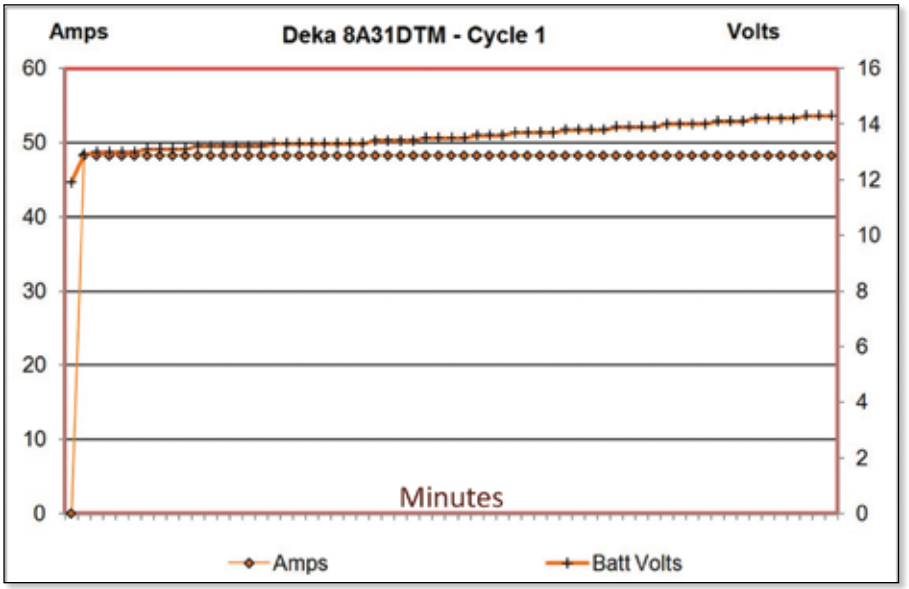
Sulfation is the enemy of all lead-acid batteries: AGM, gel, and flooded. Think of sulfation as an unavoidable disease, and a healthy charging regimen as treatment. All lead-acid batteries will sulfate. Treating the batteries correctly helps reduce sulfation and leads to longer battery life. Unfortunately, sailboat batteries rarely get the treatment to hold off the sulfation long enough to achieve a desired cycle life.

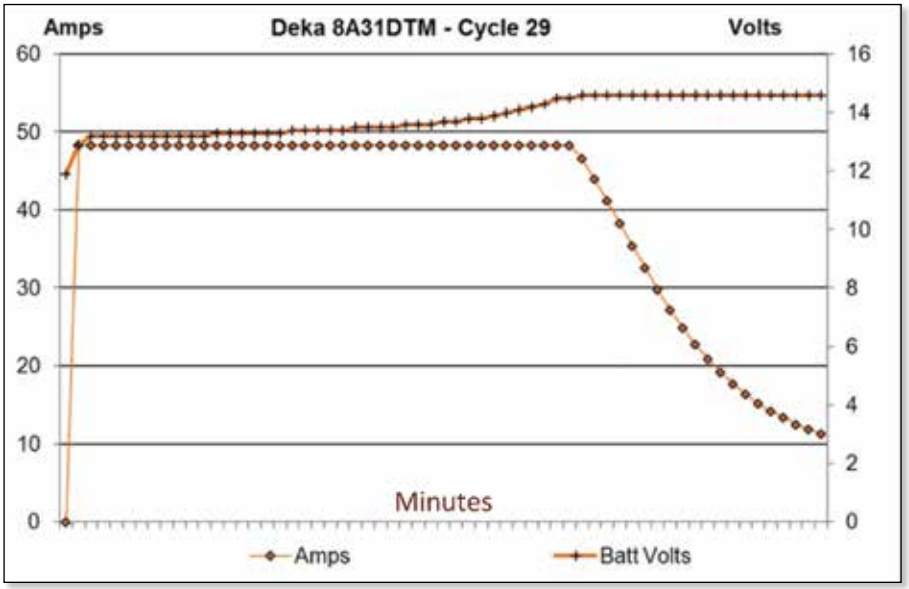
As a lead-acid battery discharges, lead sulfate forms. As the battery recharges, this lead sulfate is reconverted to lead and lead dioxide. In a perfect world, all of the lead sulfate would reconvert with each full charge cycle, but some lead sulfate never reconverts. Instead, it slowly hardens into lead-sulfate crystals and becomes permanent. The longer you go between full charge cycles and the deeper you discharge your battery, the more hard-lead sulfate you leave on the battery plates. This process reduces the amp-hour capacity that the battery is capable of delivering.

For this test, we wanted to see just how fast the effects of sulfation could set in and damage brand-new, healthy batteries. To do this, we turned to a partial state of charge cycle test.

A partial state of charge cycle test is testing in which the battery is discharged and partially recharged but does not return to 100 percent before being cycled again. This mimics what happens when we're at anchor or when we store our boat on a mooring or in a marina with no electricity. In these cases, partial state of charge operation is a fact of life—a fact of life that can be murder to batteries.

Even the most sophisticated sailboat alternator and regulator will not regularly get your batteries back to 100 percent. Most sailors don't, or won't, run the motor long enough to get there. Charging batteries to 100-percent state of charge,





During the first re-charge cycle, the Deka accepts nearly every amp we put into it (just less than 50 amps) for the full hour (top). During Cycle 29, the battery's acceptance rate sharply drops after just 40 minutes of charging. Sulfation has sharply reduced its ability to recharge. By the end of the one-hour charge cycle, this battery was only accepting 11.3 amps at 14.6 volts.

even with AGMs, takes upward of six to eight hours or more. As sulfation sets in, this time grows even longer. The effects of sulfation are cumulative.

As far as we know, this is the only test of AGMs that has looked at the effects of partial state of charge use as related to the way we use our batteries on sailboats.

After bringing the batteries up to full charge and defining amp-hour capacity, we cycled them 30 times through partial states of charge, applying just one hour of recharge, and we charted the results. (For details on our test, see the accompanying "How We Tested.")

WHAT WE TESTED

We selected three of the most popular marine AGM batteries and two new-technology AGM batteries to run through our partial state of charge testing. Considering this testing took many months to complete, we focused on the most popular AGM batteries, in the Group 31 size. Many battery vendors actually sell the same battery, privately labeled, and because testing was so time-consuming, we wanted to avoid duplications. With rated capacities of about 100 amp hours, Group 31 is the size commonly found on an average 30- to 40-foot cruising boat. Here's what our roster looked like:

Lifeline GPL-31T (105 Ah): The Concorde Battery Co. manufactures Lifeline batteries, a longtime player in the marine market. It is one of the most popular AGM batteries in use on boats today.

Deka 8A31DTM (105 Ah): East Penn Manufacturing in Pennsylvania manufactures and markets the widely distributed Deka brand batteries. This battery appears under many different labels. East Penn has a state-of-the-art recycling plant for used batteries.

Odyssey PC2150 TPPL AGM (100 Ah): Marketed as a dual-purpose battery, this thin-plate pure lead (TPPL) battery is made by EnerSys, based in Reading, Penn. This battery is also currently sold as the Die Hard Platinum AGM.

Firefly Oasis Marine Group 31 (110 Ah): Featuring materials and a design that is relatively new to the recreational marine market, the Firefly Oasis uses a patented carbon microcell foam technology that the company claims can delivery longer life and better performance under extreme conditions. The Firefly Oasis Marine AGM is distributed through Bruce Schwab Energy Systems.

China Aviation Lithium Battery Co. (CALB) SE100AHA LiFePO4 (100 Ah): This is a lithium-iron phosphate battery (LiFeP04), sometimes abbreviated as LFP. It is not a drop-in replacement for a lead-acid battery, and it is not recommended for the typical consumer. Mastervolt, Genasun, and Victron build factory-ready LiFePO4 systems, and these would be good places to begin any investigation into a LiFePO4 system for marine use.

Others: Northstar/Energy 1 sent us a battery, but it arrived too late to be included in this round of testing. It will be tested alongside a duplicate Deka battery for comparison and to verify results with the Deka battery we used for this test.

WHAT WE FOUND

AGM batteries accept lots of current in bulk charging, and this can be a real advantage for cruising boats that want to benefit from short high-amperage

Continued on page 10

Tracking Batteries

Each AGM battery we tested underwent a minimum of five discharge and recharge cycles to a loaded 11.7 volts before being ampere-hour-capacity tested. This cycling ensured that each battery had "cycled up" to its rated amp-hour (Ah) capacity. If the battery did not cycle up to rated Ah capacity, we ran a few more cycles and tested again.

All batteries were cycled in a controlled temperature water-bath set to maintain the batteries at 77 to 80 degrees. Controlling the temperature is important when conducting 20-hour capacity tests on lead-acid batteries. Used by makers to indicate capacity, the 20-hour amp hour rating is the number of amp hours that can be drawn from the battery at a slow rate (capacity ÷ 20) for 20 hours before voltage drops below 10.5 volts.

After the batteries were cycled up, we carried out two complete, constant current, 20-hour discharge capacity tests, discharging to 10.5 volts, at 77 degrees. The two results were averaged to determine the baseline capacity.

To maintain a constant temperature while cycling, batteries were put into a water bath. A data logger tracked results.

PARTIAL STATE OF CHARGE TESTS

Once the capacity was determined, each battery underwent 30 discharge cycles to 11.7 volts at its 20-hour discharge rate. The formula is simple, Ah capacity/20. For example, a 100-Ah battery is discharged at 5 amps (100/20 = 5 amps).

The 11.7-volt discharge floor was based on real-world use. Sailors often decide it is time to charge the battery bank at this voltage. In reality, 11.7 volts is lower than you should discharge your battery. On our test batteries, this represented a 70- to 75-percent depth of discharge when discharged at the 20-hour rate.

This 11.7-volt cutoff was followed by a one-hour, timer-controlled recharge at .46 of the amp hour rating. This charge rate (46 percent of capacity), is the maximum we normally see on sailboats. For example, a 100-Ah battery was charged at 46 amps for exactly one hour. We charged all batteries at the same charge percentage rate, based on each battery's Ah rating, to be as fair as possible. With any test like this, it can be difficult to treat all batteries identically, but we tried as hard as we could to keep a level playing field. In our view, these results should not be taken as an empirical data set, but rather a glimpse into what and how partial state of charge use can affect your batteries.

At the end of the 30 PSOC cycles, each battery was discharged to 10.5 volts on cycle 31 and then recharged to 100 percent state of charge. The batteries were determined full at absorption voltage and 0.5 percent net accepted current. For the 100-Ah Odyssey battery, this was 14.7 volts and 0.5 amps.

For the final Ah capacity testing, each battery was left to float for an additional 24 hours after attaining 0.5 percent net acceptance at absorption voltage. The batteries were then left to rest for 24 hours before resuming testing. Each battery was charged in accordance with the manufacturers' recommended max charging voltages.

Absorption voltages:
Odyssey = 14.7 volts
Lifeline = 14.4 volts
Deka = 14.6 volts
Firefly = 14.4 volts
LiFePo4 = 14.0 volts (maximum of 3.5 volts per cell)

POST PSOC CAPACITY TESTING

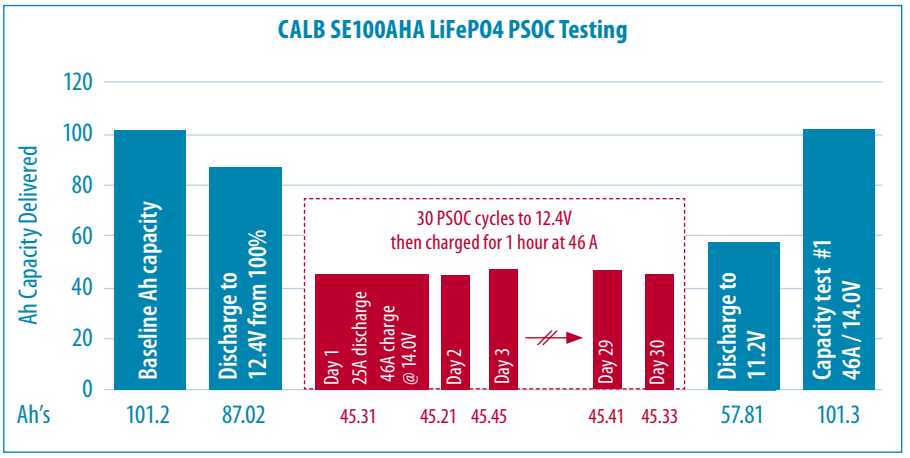
Once fully recharged, the batteries faced another 20-hour discharge test to see whether the battery had lost any capacity. If it did not recover fully, a second capacity test was performed. If it did not come back to full capacity after the second cycle, testers tried (up to three times) alternative means of restoring capacity, as recommended by the manufacturer.

For discharging the batteries, we used two identical Array 40-amp DC Constant Load Capacity Testers. These test machines have the ability to hold current steady out to the thousandths of an amp while battery voltage decays. This is an important aspect of any capacity test as it is only valid if the discharge current can be held steady at exactly the 20-hour rate for the entire duration of the discharge test. The array testers utilize dedicated non-current carrying voltage sensing leads in order to terminate discharge at a precise battery terminal voltage.

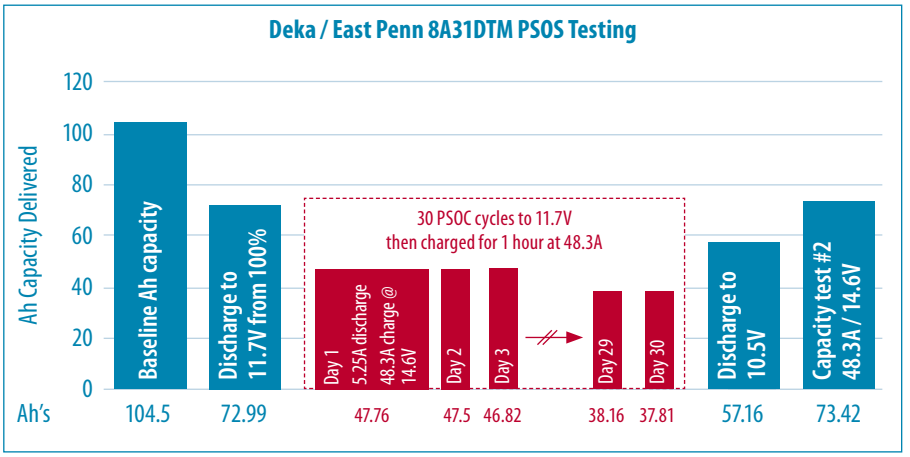
For charging, we chose the BK Precision model 1900 Variable Bench Top Power Supply. These power supplies are capable of up to 60 amps of charge current and a maximum voltage of 16 volts. Both voltage and current can be set independently and are completely variable. These are highly accurate adjustable chargers that also utilize dedicated voltage sensing leads for accurate battery terminal voltage settings.

Our data-logger tool was a Bogart Engineering Penta Metric Data Logger, and this was used to create some of the charge and discharge curves accompanying this article.

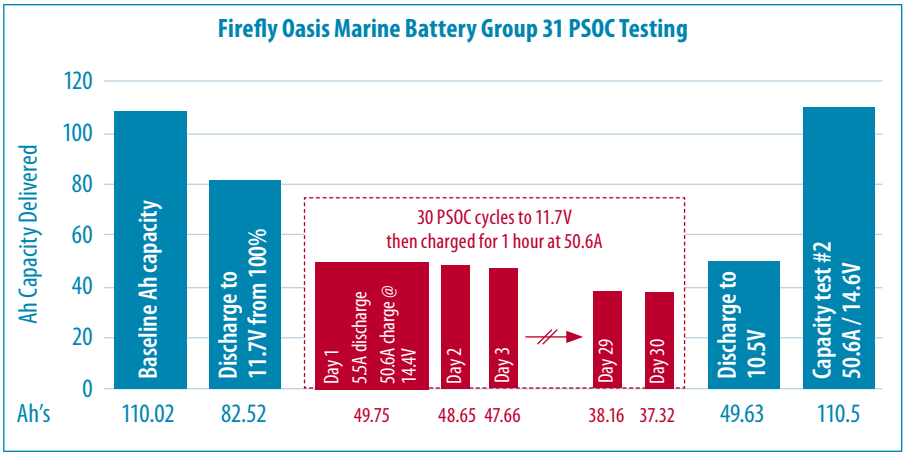
We used a digitally controlled aquarium heater and a Rubbermaid tub to maintain water temperature. The water bath was a critical aspect of this testing, and without it, the test room would have needed to be at 77 degrees for many months.



The LiFePO4 (lithium phosphate) battery from China went through a completely different discharge and charging regimen. It quickly bounced back to full capacity.



After three capacity test, the Deka battery's maximum capacity of 73.42 amp hours (on the second capacity test) was short of its rated 105 amp-hour capacity.



Initially, the Firefly Oasis did not recover its full capacity, but after a second complete discharge cycle and a full recharge it recovered all its original capacity—and more.

Continued from page 8

charging cycles. However, chronic partial state of charge results in sulfation, and this drastically shortens the amount of time the battery is capable of accepting bulk charging.

AGMs are, in one sense, a Catch 22. You paid more for an AGM battery for its fast charge acceptance rate, and shorter engine or generator run times, but if you continue this partial state of charge operation, AGM batteries begin to behave more like flooded batteries in terms of their charge acceptance rates. And while a flooded battery's capacity can often be partially restored through equalization, the effects of partial state of charge are often permanent in AGMs.

What was striking in our tests was the speed at which the AGM batteries began walking down when put through partial state of charge conditions. On the first charge cycle, every single AGM battery we tested took the full charge rate (46 percent of amp-hour capacity) for the entire hour. The batteries remained in the bulk charging stage for the entire hour, allowing for very efficient charging. By the second cycle, some batteries were already beginning to walk down, and were attaining the absorption voltage by the end of the hour. Within a few cycles, all of the AGM batteries were attaining absorption voltage near the end of the one-hour recharge. With each successive PSOC cycle, absorption voltage was attained earlier and earlier in the short one-hour charge cycle, and the batteries began slowly walking down. This walking down effect in usable capacity was caused by sulfation.

It was interesting to see how the LiFePO4 battery capacity did not diminish through the course of our testing. The reason is clear: LiFePO4 does not sulfate. This testing shows why you need to fully recharge AGMs as often as possible.

As the accompanying tables indicate, when a sailor recharges his battery for one hour each day (at an assumed 80 amps from his alternator), he is not charging as his battery as fully as he might think. Under this regimen, all of the AGM batteries lost usable capacity, from the one-hour recharge from cycle No. 1 through cycle No. 30. If we look at the spread between the highest to lowest losses in usable capacity, in amp hours, on all the batteries over the 30 cycles, it looks like this:

Firefly: 49.75 to 35.10 = -14.65 Ah spread

Lifeline: 45.56 to 31.53 = -14.03 Ah spread

Deka: 47.76 to 37.81 = -9.95 Ah spread

Odyssey: 44.69 to 34.76 = -9.93 Ah spread

LiFePO4: 45.74 to 45.04 = -0.7 Ah spread.

Note that the highest to lowest was not necessarily beginning and end. Some batteries bounced up and down, so highest-to-lowest, one-hour recharge usable capacities were simply taken at the highest and lowest usable capacities over the 30 cycles. The complete set of tables indicating all 30 cycles are available in the online version of this article.

FIREFLY OASIS CARBON FOAM

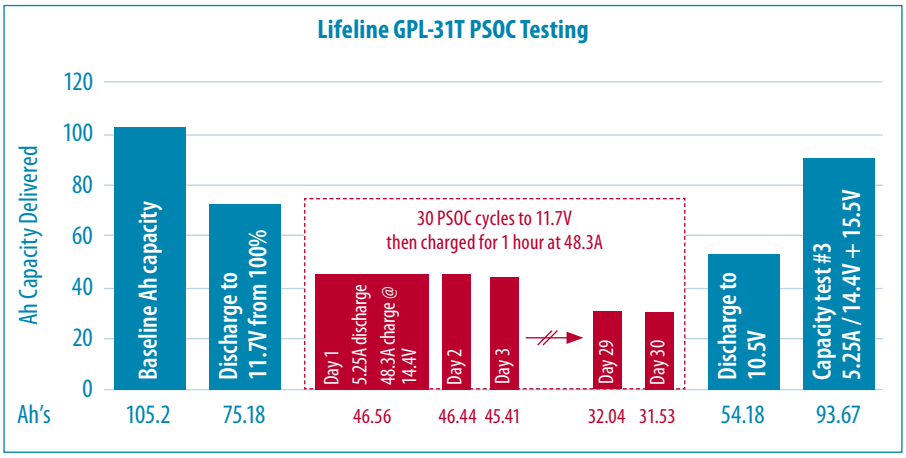
The Firefly Oasis Marine Battery is rated as a 110-amp hour battery, and for our test, it started at 110.02 amp hours. On the first PSOC cycle to 11.7 volts, the battery's usable capacity was 49.75 amp hours. The Firefly then walked down and hit a low point of 35.1 usable amp hours at cycle No. 21.

The Firefly's usable capacity bounced up and down more than other batteries in our testing. The lead engineer at Firefly suggested the peaks occurred after the battery remained at absorption voltage slightly longer.

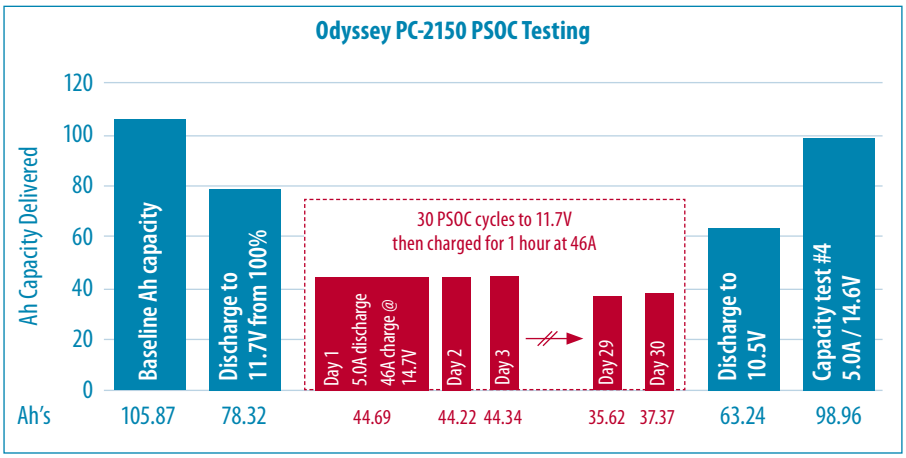
At the end of 30 cycles, we conducted the first capacity test (discharged to 10.5 volts and then recharged to 100 percent, see "How We Tested"), and the battery delivered just 94.03 amp hours, a loss of nearly 16 amp hours in capacity from the original baseline. This was disappointing, especially for a battery that claims to resist sulfation. Firefly's lead engineer instructed us to try another capacity test. Indeed, after a second discharge-recharge cycle, the battery not only regained all its capacity, but increased slightly (by 0.5 amp hours) to 110.5 amp hours.

Ultimately, the Firefly lived up its makers claims. In just a few deep cycles, with full recharges, these batteries can regain most—and in some cases all—of the lost capacity due to partial state of charge cycling. The battery required back-to-back deep cycles, both with 100 percent full recharges, but it worked.

Bottom line: Although this AGM technology is still new to the recreational marine market, it is certainly something to watch for in the future.



The Lifeline battery reached its highest capacity after a second equalization charge (described in article text). The equalizing followed a normal charging regimen.



The Odyssey battery gained about 2 amp hours in capacity when it was charged slowly (5 amps) to 14.7 volts, and then held at that voltage for eight hours.

ODYSSEY PC2150

The Odyssey's maker, EnerSys, was the inventor of the orbital battery technology (Optima) and is well ensconced in the military, aerospace, and backup battery systems markets. The Odyssey's thin-plates pack more plate surface area into the same space as other designs, enabling it to provide both very high cranking power cranking pulses and longer life.

It sounds counterintuitive that a thin plate battery can be used for deep-cycling applications, but the Odyssey TPPL AGMs have a strong following. The PC2150 is a Group 31 TPPL AGM battery rated at 100 amp hours. This particular battery tested above its rating with a baseline capacity of 105.8 amp hours.

The Odyssey walked down a little slower than other batteries and did not dip as deeply at the end of 30 partial state of charge cycles. At the end of the partial state of charge capacity testing, however, the PC2150 could not get back to its baseline as-new capacity. It started life at 105.8 amp hours, and after three capacity tests, it delivered a high of 98.96 amp hours. For testing purposes, this represents a capacity loss of approximately 6.7 percent, but if we consider its rated capacity of 100 amp hours, it only lost a little over 1 percent. The final capacity test on the PC2150 involved a recharge at the 20-hour rate of 5 amps. The battery actually gained 2.17 amp hours when charged slowly at 5 amps to 14.7 volts and then held at 14.7 volts for eight hours.

Bottom line: Overall, the Odyssey handled the partial state of charge cycling fairly well, and the higher absorp-

12 Ways to Extend Your AGM Battery's Life

1. Charge to full as often as possible; this point cannot be over emphasized.
2. Get back to at least 80- to 85-percent state of charge (full capacity) with each charge cycle, and get to 100-percent state of charge as soon as you can thereafter.
3. Do not regularly discharge your bank below 50-percent state of charge.
4. Size your most powerful charge source, usually an alternator or inverter-charger, for a minimum of 20 percent of bank capacity. Odyssey TPPL AGM's prefer 40 percent of amp-hour capacity as minimum charge current.
5. Use smart chargers. Not all chargers that claim to be "smart" are in fact smart.
6. Use temperature-compensated charging for all charging sources.
7. Use smart solar controllers. Some solar controllers start each day at a new absorption voltage charging cycle. This is not healthy for AGM batteries that have low self-discharge and minimal parasitic loads when left unattended on-the-hook. Smarter controllers have a voltage trigger to pop them out of float mode. If they don't drop to the trigger voltage, they remain in float.
8. Using the correct float voltages is a critical aspect of AGM batteries. Chargers that use "dip switches" for programming often lack the correct voltages for both absorption and float settings.
9. Use an alternator temperature sensor and external regulator, if possible. AGM batteries can demand a lot from an alternator, and the heat created can shorten its life or cause premature failure.
10. For the best charging performance, minimize the voltage drop in system wiring. Even a 3-percent voltage drop at 14.4 volts means just 13.96 volts at the battery terminals. Incorrect voltage sensing robs you of the fastest charging potential, especially during short duration, high current charging events.
11. Know your correct state of charge at all times, even if this means investing in a battery-monitoring device. It will help in overall cycle life. If you are using voltage to determine state of charge, be sure you are getting it as accurate as possible.
12. Avoid installations in engine rooms or hot areas of the boat. Heat shortens battery life.

tion voltage (14.7 volts) seemed to help minimize capacity loss.

DEKA / EAST PENN 8A31DTM

The Deka /East Penn 8A31DTM is a hybrid, dual-purpose AGM battery. Widely distributed under many different brand labels, this is perhaps the most popular AGM battery on boats today. This particular battery is sold by Deka, West Marine, NAPA, many Sam's Clubs as a Duracell, O'Reilly Auto, Power-Tec, MK Battery, and under numerous other smaller labels. It is one of the least expensive AGM batteries you will find on the U.S. market. Some labels offer better warranties, so it can pay to compare.

The 8A31DTM is rated at 105 amp hours. This particular battery tested slightly below its rating with a baseline capacity of 104.5 amp hours. Netting 104.5 amp hours from a 105-amp-hour battery is certainly acceptable.

The Deka 8A31DTM walked down at a reasonable pace compared to others during the partial state of charge testing, and handled the partial state of charge cycling well. Its lowest usable capacity, after the one-hour recharge during the 30 PSOC cycles, was higher than that of all the other lead-acid batteries, meaning it walked down slightly less.

At the end of the partial state of charge testing, however, the 8A31DTM had lost a large percentage of its original 104.5 amp-hour baseline capacity. Even after three capacity tests, the 8A31DTM could only deliver 73.42 amp hours. This represents a surprisingly high capacity loss, during the partial state of charge testing, of approximately 30 percent of its as-new tested capacity.

Bottom line: Deka suggested that our test did not bring the battery up to full capacity prior to capacity testing. We worked closely with Deka's tech team to bring the battery to full capacity, so this seems unlikely, but to confirm whether our particular battery was an anomaly, we will be testing a second Deka battery. The decline could be inherent to the Deka's intended dual-purpose design, but we can't really be sure until we test a second battery.

LIFELINE GPL-31T

The Lifeline GPL-31T is a deep-cycle AGM Group 31 battery that, as far as we know, is not privately labeled. The manufacturer, Concorde, has a long history of providing batteries to the recreational vehicle market as well as to many of the top-tier boat builders. The company is known for its robust build, excellent tech support, and the willingness to stand behind the product.

The GPL-31T is rated at 105 amp hours, and this particular battery tested slightly above its rating with a baseline capacity of 105.2 amp hours. The battery walked down at a bit steeper pace than others during the partial state of charge testing, but it has a secret weapon that other AGMs do not. The Lifeline can be equalized, or as Lifeline calls it "condition charged," when needed.

To condition charge a Lifeline AGM, you can apply a temperature-compensated voltage of up to 15.5 volts for as long as eight hours. At the end of the partial state of charge testing, the GPL-31T had lost a bit of its original 105.2 amp-hour baseline capacity. On the first capacity test, the battery turned in a capacity of 89.43 amp hours. For the first capacity test, we charged it at 48.3 amps and 14.4 volts until current was at 0.5 amps; we

then ran a 24-hour float charge voltage; and finally let it rest for 24 hours disconnected. (The Lifeline AGM charges at a lower absorption voltage than the Odyssey or Deka.) We then ran the same recharge cycle, but once the battery's acceptance hit 1 amp at 14.4 volts, we adjusted the voltage to 15.5 volts for four hours, then floated and rested the battery for 24 hours. This bumped up the capacity to 91.21 amp hours. Noting an increase in capacity, we did the same thing again. After that "condition charge," the battery bumped up to 93.67 amp hours.

Finally, we went back to the standard charge protocol of 14.4 volts to 0.5 percent acceptance and retested. This time, the battery dropped back slightly to 93.02 amp hours. This was the only battery that got a fourth capacity test, which we performed only because it had these special charge capabilities, which our testing confirmed, does seem to work. Eight total hours at 15.5 volts over two consecutive back-to-back capacity test cycles yielded a small but definite improvement of almost 4.25 amp hours in regained capacity.

Bottom line: Overall, the Lifeline lost nearly 11 percent of its as-new capacity in the 30 partial state of charge cycles. The "condition charging" helps, but might need to be done more often in a heavy PSOC cycling application. It would be best to consult with Lifeline on this.

CALB SE100AHA LIFEPO4

We included this battery to see how it did against lead-acid in a partial state of charge test. This battery consisted of four CALB SE100 prismatic LiFePO4 cells (LFP) wired in series. This is not how LFP batteries would be installed on a boat; we did this only for testing purposes in a very controlled environment.

LiFePO4 batteries perform differently from lead acid but should also charge at lower voltages, closer to gel or below (13.8 to 14 volts is ideal), and unlike lead-acid batteries, you don't want to float charge LFP batteries. LFP batteries also have considerably higher resting voltages than do lead-acid batteries. A pack like this, under normal house loads on a boat, would rarely dip below 13.2 volts.

This battery was not discharged or charged based on a 20-hour rate. LiFePO4 batteries have a minimal Peukert effect, so drawing them at a low current won't really yield much more capacity. (According to the Peukert's Law, as the rate of discharge increases, the battery's available capacity decreases.) For this reason, LiFePO4 batteries are rated at a specific discharge load, not time and discharge load like AGMs. Most makers rate LiFeP04 batteries at 30 percent of capacity (.3C), as is shown in our table.

This 100 amp-hour battery was discharged at 25 amps and charged at 46 amps. We discharged it to approximately 86 percent depth of discharge, far more than we did with the flooded batteries. The widest gap in capacity during the 30 partial charge cycles was just 0.7 amp hours. If we'd counted amp hours instead of using a cut-off voltage to determine when to stop charging, this small variation would likely disappear.

This battery tested at 101.2 amp hours after we manually balanced the cells. After 30 partial state of charge cycles, the LiFePO4 battery tested at 101.3 amp hours, showing effectively no loss in capacity. This is what LFP batteries do best, partial state of charge cycle.

Bottom line: LiFePO4 batteries are still expensive, and dropping an LFP into a lead-acid charging system can lead to expensive and possibly dangerous problems. Given time, LFP will be a contender, but today, it remains out of reach of all but the very technically inclined sailor, or one with deep pockets.

CONCLUSION

The results of our test were clear: The longer any lead-acid battery is left at less than 100 percent state of charge, the more permanent harm sulfation is causing to the battery. Except for the Deka battery (which we will be retesting), these batteries generally lived up to our expectations.

Because of small variables in production lines and distribution (shelf storage times and maintenance can also impact performance), a single test is not enough for us to pick an overall winner between the Odyssey or the Lifeline, the two "mainstream" batteries in our test. Both are equally capable of meeting a sailor's house bank needs. We did not evaluate cold cranking (starting ability), something the Odyssey claims to excel at. The Firefly topped both of these in terms of recovering capacity, but because we have so little data from the marine market on this product and the support network is unproven, we're hesitant to enthusiastically jump on the Firefly bandwagon. We intend to followup with some field-testing. Stay tuned.

Keep in mind that the "abuse" that our test batteries endured is less harmful than what commonly occurs on our boats. It can be even more damaging to leave a battery to stand at 50 percent state of charge, for multiple days, than to conduct multiple back to back 100-percent discharge capacity tests followed by a full 100-percent recharge.

Heat is also a major factor in overall cycle life. A worst-case scenario would be a sailboat with only an alternator for charging that anchors or moors in an area where the batteries remain above 80 degrees. (Bahamas, anyone?)

Boaters on moorings or docks with no charging capability other than the alternator should consider an alternative means to get the batteries back to 100 percent state of charge as soon as possible after each discharge. Even a small 20- to 60-watt solar array with a charge controller can greatly extend battery life for a boat without shore charging capability.

In the accompanying sidebar "Tips and Techniques," we offer guidelines to help prolong battery life, but basically, it boils down to this: Do your best to get your batteries back to 100 percent state of charge as often as is possible, using your manufacturers prescribed voltages, and your batteries will thank you.

CONTACTS

CALB, www.lithiumstorage.com

EAST PENN, 610/682-6361, www.eastpennmanufacturing.com

FIREFLY, 309/402-0701, www.fireflyenergy.com

LIFELINE, 909/599-7816, www.lifelinebatteries.com

ODYSSEY, 610/208-1991 www.odysseybattery.com

Carrying out a one-drop engine-oil test, using a kit or plain cardstock, at regular intervals allows you to track and compare the health of your engine.

DIY Engine Oil Tests

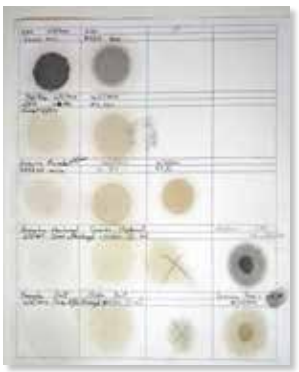
How useful and accurate are one-drop tests?

Sailors obsess over the health of their engine; it is the heart of the boat (other than the rig, sails, and through-hulls). Failure is inconvenient, expensive, and even dangerous. And sailors love their maintenance, or so it seems. Anything that promises to ease the mind for a few dollars merits investigation.

A laboratory can test engine oil for many things to determine its health. A typical lube test kit costs $25 to $50, takes two to four days to complete, and provides a wealth of information on internal wear and contaminants, as well as other changes in chemistry and physical properties. For heavily used large equipment and fleets, this is practical and common, but for smaller engines, a quick field check is easier to justify. Fortunately, many of the changes in oil chemistry result in physical changes that can be observed though paper chromatography. There are a few packaged one-drop test kits designed for field-testing oil, and there is also the less official "business card test," which is often mentioned on the Internet. To compare the performance of these two types of field tests, we decided to try both on various engines.

PS's lead tester for this review is experienced in the engine-lubricants business and often carries out tests the laboratory way. Based on his experiences in the lab, we knew that a sort-of chromatography happens as oil drops fall on note papers and spread in characteristic patterns. (Chromatography is the process in which a chemical mixture, carried by a liquid or gas, is separated into components as a result of differential distribution of the solutes.)

It seemed reasonable to us that by codifying these differences, at least a few common problems could be spotted; however, we anticipated less accuracy than the lab tests. Because oil contamination from fuel or coolant are the most common concerns for marine engines, we focused on these.



The Engine Check-up kit (far left) includes covers for unused areas; the covers pop out easily and keep errant drips from accidentally ruining the test card. Testers created their own test card using 65-pound cardstock (at left).

TEST SIGNIFICANCE

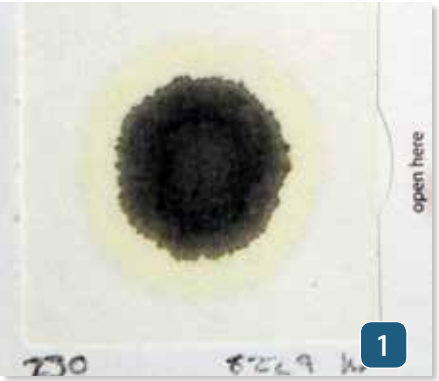
The makers of one-drop test kits supply interpretation cards, intended to help the user judge the meaning of what he sees. How the oil and particles move through the paper is affected by particle size, chemistry, and viscosity. Although the tests are not quantitative, they can reveal changes in physical characteristics.

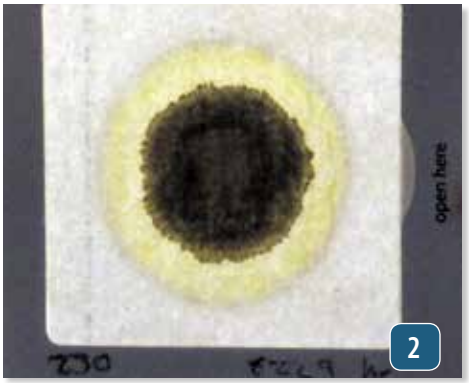
Dirt: Obviously, the darker the oil, the more contaminated it is, but the size of the particles is also important. So long as the dispersants can keep up and the particles remain relatively small, abrasive engine wear is minimal. Diesel oil becomes black with soot very quickly, but that alone is not troubling. What we are concerned about is larger particles, and these will clog the paper and result in hard-edged rings.

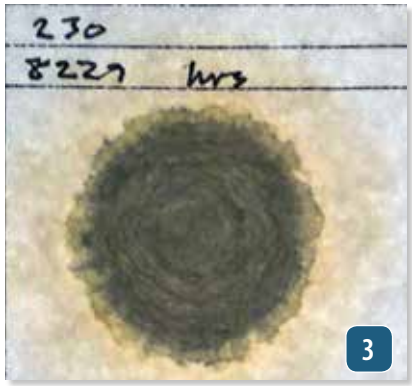
These large particles can indicate filter bypassing (very dirty oil has clogged the filter), coolant leaks (see below), or excessive wear. The engine must be warmed-up before sampling. You must warm up the engine before sampling; otherwise, you might get a false reading, since small particles will have had time to agglomerate and appear as large ones.

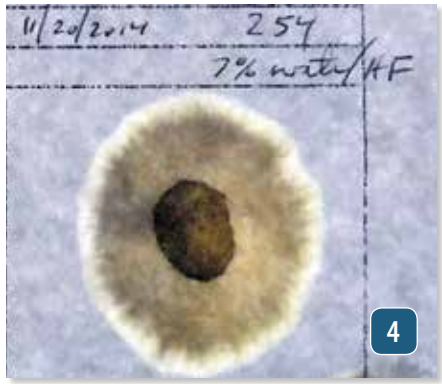
Coolant leaks: Sometimes you will see the water directly as dots, either clear or black; they will draw soot particles to the interface. If the contamination is very high (over 15 percent), the oil will be brown or milky rather than black. More often, if the contamination is slight

Photos by Drew Frye









DIESEL ENGINE OIL

1. This Engine Check-up test card shows oil from a large Cummins diesel that is in good condition. The test was carried out about halfway between oil changes.
2. This is the same Engine Check-up test card as No. 1, but it's shown with backlighting. Backlighting can help when examining drops, especially with very dirty oils and in viewing the fuel-dilution ring.
3. Testers dropped the same Cummins diesel oil on 65-pound cardstock for comparison. This view is shown with backlighting.
4. The test spot from a diesel engine that has a blown head gasket and 7-percent water in the oil. About 15-percent coolant had leaked into the engine (based on key additive analysis). Note that the oil is more brown/milky than the healthy-engine oil in No. 1. Also note the hard edge in the center ring, and that the center ring is smaller (coolant/water mix clogs the pores). This test spot is on cardstock with backlighting.
5. This is the same oil drop as No. 4; it's also on cardstock but without backlighting.

or uncured over a long period, the water will evaporate during operation. We will see only the residual effect of droplets that had been dispersed, drew dirt particles together, and then evaporated away, leaving only oversized dirt-particle agglomerations behind. In this case, the oil will look much like very dirty oil, with a smaller, hard-edged center ring. Sometimes, there are slight changes visible due only to condensation (an engine that has not been used much). Coolant contamination is serious and must be confirmed by laboratory testing for glycol.

Diesel and gasoline: Being much thinner than oil, diesel and gas fuels create a large, light-colored ring, beyond the oil spot. If the gasoline contamination is severe, you'll smell it before you can see the difference. (Gasoline evaporates before the ring can spread too far.) With diesel, a nice wide ring will appear. However, this is dependent on temperature and oil viscosity.

WHAT WE TESTED

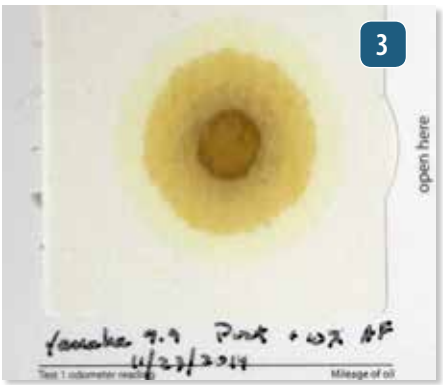
We tested two methods of do-it-yourself, one-drop, engine-oil testing: the widely available Engine Check-up test kit and just plain cardstock (Neenah Bright White Cardstock, 65-pound) that you can get from any office supply store. We also tested several types of filter paper and blotter paper, but none performed better than plain cardstock, so we did not include those results in this report. We did not test business cards because of variability in the cardstock.

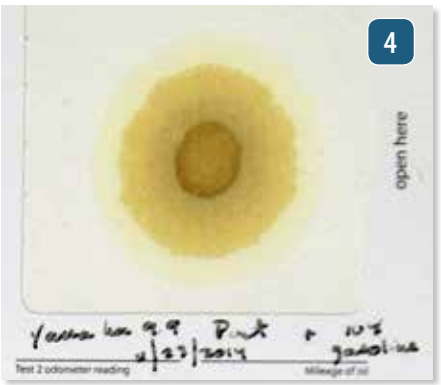
HOW WE TESTED

We tested the oil from cars, heavy-duty diesel trucks, and outboard engines. We tested engines in regular use, engines in intermittent use, and engines with known cooling system leaks. We contaminated oil samples with measured contaminants. While results cannot be expressed quantitatively, a photo essay of typical results paints the picture (see accompanying photos).

The one-drop method is a very simple process, accessible to anybody under field conditions, but there are caveats.

- Drop size must be relatively uniform. The paper must be laid flat until the oil is absorbed. Temperature variations have some effect; we recommend finding a room-temperature location. We found the floor of a car with the heater on medium worked well in winter conditions. If you use blotter paper (cardstock), preprint or draw rule lines, and label the boxes before applying the oil drop. The drop should be left flat for 24 hours before reading. Backlighting the developed blot can help when examining drops with very dirty oils and in viewing the fuel-dilution ring.
- Because reading the drops is very subjective, this method is best used to monitor an engine over time. Test oil midway between oil changes; consistency in timing is important. Only after a few samples on the same engine will changes be reliably observable.
- If you have never used this test before, try a drop from a known good engine first to provide a baseline; if you have a gasoline engine, this can be the family car. If you change oil grade or type, that will change the results.
- If you intend to use cardstock, get enough to last a few years; changing stock will dramatically affect the drops'





appearance. Once developed, sheets can be stored in a Ziplock bag. Incidental contact does not distort patterns.

ENGINE CHECK-UP

The Engine Check-Up test kit includes a blotter sheet with windows for six drop tests. Each window has a cover that is easily removed, but it will not fall out accidentally; testers found this convenient for preventing accidental drops. A brochure and interpretation sheet is included. We have posted an a copy online as an example.

The Engine Check-Up paper blots were somewhat more readable and consistent over time than cardstock; the paper has been treated to stabilize the chromatogram (oil pattern). The covering material and frame for notes work well, minimizing smears to unused sections. (Always approach from the cover side—drops have a nasty habit of falling in the wrong place.) The patterns are easier to read, especially for clean oils, though the accuracy and information for both Engine Check-Up and cardstock are equivalent, in our opinion.

We did not find that contaminants always looked exactly like the Engine Check-Up interpretation sheet. Glycol and water were more likely to look like the "Grime" indication, particularly for gasoline engines. Gasoline dilution did not show very well; we suspect it evaporated before it could spread, though it was easy to smell. But we did feel that when we had a good baseline of tests, we could see minor changes. The more consistent the technique (temperature of oil, drop size, temperature while developing, engine hours), the more sensitive the test.

The Engine Check-Up kit costs $20 for a six-sample kit, and a refill is $15.

Bottom line: We recommend this as a tool for monitoring engine oil for coolant leaks, fuel dilution, and general contamination.

CARDSTOCK

We tested different types of cardstock and noted only small differences, so it appears any un-coated business cardstock will do. The only major downside to using cardstock rather than a ready-made kit is that there is no interpretation card. We've shared a few photos here, but there are many permutations, and you'll have to build your own experience base.

The Neenah Bright White Cardstock we tested cost $16 for 250 sheets.

Bottom line: This method is very inexpensive and showed little difference in accuracy from the ready-made test cards, as long as you stay with the same batch of cardstock.

GASOLINE ENGINE OIL

1. This Engine Check-up test card shows the oil blot from a 2006 family car that had been driven no more than a few miles for one month.
2. This is the same car's oil after one hour on the interstate (Engine Check-up test card).
3. This oil from a Yamaha 9.9-hp outboard has 10-percent engine coolant added and was heated to 250 degrees to dry, which is typical of slow leaks, on an Engine Check-up card. Note that the center circle is smaller (coolant/oil mix clogs the pores).
4. This is the same oil as No. 3, but with gasoline added (Engine Check-up card). There's not much visible difference, but the smell was obvious.

CONCLUSIONS

Although a one-drop chromatogram is a poor man's substitute for laboratory oil testing, it is useful for monitoring a known engine. Consistency of technique is vital: The engine must be warmed-up, oil-drop size should be uniform, oil grade and type should not change, air temperature while developing should be consistent, and engine hours must be consistent. If any change in the blot is noticed, arrange a lab test to accurately determine wear metals, or coolant and fuel contamination. We would not extend oil-change intervals based on a blotter test, since it does not measure acidity or additive depletion.

Don't rely on a blotter test for the pre-purchase evaluation of a used boat; there are too many unknowns that could skew results. A perfectly good engine can look bad, if it sits too long and a problematic engine with a recent oil change can seem good as new.

You don't need to shell out $3 a pop for "official" blotters once you have a comparison chart (see this article online for an example) and have had some practice. The card stock served perfectly fine for tracking engine health.

CONTACT

ENGINE CHECK-UP, 732/359-7558
www.enginecheckup.com

Photo by Bill Bishop

Playing with Cards

Practical Sailor *explores the not-so-simple universe of secure digital media cards.*

Media card options abound, but which one is right for your chartplotter?

As we dug into the topic of electronic storage media—the memory cards we use for routine software updates on our marine electronics—we found that even the makers of our marine electronics were a little confused about which memory cards worked with their own systems. We soon realized that a data table indicating which cards worked with which electronics would be very handy. It was one of those easier-said-than-done enterprises that dragged on for weeks. Hopefully, our tables, compiled by *PS*'s resident electronics expert, Bill Bishop, will be helpful as you dust off your chartplotter for the coming season.

CHOOSING AN SD CARD

All too often, when describing software updates, the owner's manual says something like: "Load the software on an SD card and update your system." What isn't clearly said is what type of SD card? What memory size? What speed class?

What card you need can depend on what you are using it for. There are four common uses for SD cards on your boat.

- First is saving navigation data such as waypoints, routes, and tracks, which you should do on a regular basis, in the event of a major malfunction of your chartplotter. This typically requires only a small amount of memory, so a card of 1 gigabyte (GB) or smaller will work.
- Many chartplotters require an SD card to update the software. This, too, should be done periodically. All manufacturers post software updates on their websites. For most chartplotters, a 2-gigabyte legacy SanDisk card will suffice.
- Some chartplotters such as Raymarine's new eSeries and Furuno systems allow you to download charts onto SD cards. Carefully check the size of these downloads, and ensure you have a card that is large enough to hold the data. These can be very large files.
- Sonar recording is becoming common on many of the new systems. Like chart downloads, sonar recording can require a lot of memory. As an example, Garmin sonar recording requires about a gigabyte of memory storage per hour of recording.

SECURE DIGITAL CARDS 101

Card type is the key to understanding the memory card family. We are only dealing with SD (secure digital), SDHC (secure digital high capacity), and SDXC (secure digital extended capacity) cards in this article.

SD card: The now legacy SanDisk standard cards store up to 2 gigabytes of data and have the SanDisk logo and memory size on the label. Although still available, they are becoming a bit more difficult to buy, and can be more expensive per gigabyte when compared to newer cards. In most cases, a SDHC card will do the same job of an SD card in newer systems.

SDHC card: These high-capacity cards are fairly common. They range from 4 to 32 gigabytes in size. On each card, you will see a circled number (2, 4, 6, 8, 10), indicating the speed class. The number represents the number of megabytes the card can write per second. A variant of this card type can also use the Ultra High Speed (UHS) format. A card designated as UHS I is the equivalent of a card in the 10 speed class. A card rated as UHS II will support speeds up to 30 megabytes (MB) per second. For all chartplotter software upgrades, the UHS speed class cards are not required. In some cases, they might not work.

SDXC card: These extended capacity cards start at 64 gigabytes and go up to 2 terabytes (TB, 1 TB is equal to 1,000 GB). SDXC cards support the UHS speed formats. At the time of writing, Furuno's TZT Touch supports this large class of card for chart storage and handling. Some Garmin products can use the SDXC class cards, but they must be reformatted from the exFAT to FAT 32 format. This can be done with your PC or Mac.

Micro SD: A micro card is very small, about the size of your fingernail. Most cards available in the standard card format are also available in the micro sizes. You can buy them as a stand-alone chip or with a full-sized adapter card that fits into a standard SD card slot. The micro SD cards are used in newer Raymarine, Garmin, and Navico multi-function displays.

Generally, when matching cards to your device, you need to keep in mind that no SD card reader is typically forward compatible to newer card types, but most are backward compatible. For

PS INFO GUIDE MEMORY CARD COMPATIBILITY

MAKER / PRODUCT		SANDISK					SANDISK MICRO		THUMB DRIVE
		CF 128MB	SD 2GB	SDHC 32GB	SDXC 64GB	SDXC 128GB	SDHC 32G	SDXC 64GB	
RAYMARINE	CLASSIC C-SERIES C70/C80/C120	X (1)							
	CLASSIC E-SERIES E80/E120	X (1)							
	A50/A50D/A57D/A70/A70D	X (1)							
	C-SERIES WIDE C90W/C120W/C140W			X					
	E-SERIES WIDE C90W/C120W/C140W			X					
	A-SERIES A65/A67/A68/A75/A77/A78/C95			X					
	A-SERIES C97/C98/C125/C127/C128			X					
	C-SERIES C95/C97/C125/C127			X					
	E-SERIES E7/E7D/E95/E97/E125/E127/E165			X					
	GS-SERIES GS95/GS125/GS165			X					
	AIS650		X						
GARMIN	GPSMAP 2XXX, AND 3XXX **								
	ECHOMAP 50/70						X	X (6)	
	ECHOMAP DV 43, 44, 53, 54, 73						X	X (6)	
	ECHOMAP SV 73, 93, 94						X	X (6)	
	GPSMAP 420/430/440		X (2)	X (2)	X (6)				
	GPSMAP 421/431/441			X	X (6)				
	GPSMAP 520/530/540		X (2)	X (2)	X (6)				
	GPSMAP 525/535/545		X (2)	X (2)	X (6)				
	GPSMAP 526/536/546			X	X (6)				
	GPSMAP 527/547						X	X (6)	
	GPSMAP 600			X	X (6)				
	GPSMAP 7X0 SERIES			X	X (6)				
	GPSMAP 7X1						X	X (6)	
	GPSMAP 8XX/1XXX SERIES			X	X (6)				
	GPSMAP 4XXX, 5XXX SERIES		X (3)	X (3)	X (6)				
	GPSMAP 6XXX/7XXX SERIES			X	X (6)				
	GPSMAP 8XXX SERIES			X	X (6)				
	GPSMAP 7407/7607						X	X (6)	
	GPSMAP 7408, 7608, 7410,			X	X (6)				
	GPSMAP 7412, 7612			X	X (6)				
B&G	ZEUS						X		

These tables contain card types and sizes compatible for each device. In most cases, only the largest usable SD card is shown since SD cards are typically backward compatible to smaller card sizes. When more than one compatible size card is listed (as in some Garmin units), updated software is required to accept the higher-capacity cards. Smaller sized cards (2 GB) will generally be enough for software upgrades and saving user data. For chart storage and sonar recordings, larger sized cards will be needed. See footnotes on the facing page for further table explanation and special instructions.

example, if your card reader can use SHXC cards, it should work with both the SDHC and SD cards. Compatible memory limits are more flexible, since this is often controlled by the chartplotter's software, which can be updated. For example, an early version of Garmin's 5000 series chartplotters could only use up to a 2-gigabyte card, but with later software updates, it could use up to an 8-gigabyte card.

Some computers have built-in card readers, but you will usually need an external card reader to download your charts or updates from your computer.

PS INFO GUIDE MEMORY CARD COMPATIBILITY

MAKER / PRODUCT		SANDISK					SANDISK MICRO		THUMB DRIVE
		CF 128MB	SD 2GB	SDHC 32GB	SDXC 64GB	SDXC 128GB	SDHC 32G	SDXC 64GB	
NORTHSTAR	6000I	X							
	8000I								X
LOWRANCE	ELITE SERIES (NON HDI/CHIRP)		X						
	ELITE SERIES HDI/CHIRP			X					
	HDS GEN1/GEN2/GEN2 TOUCH			X					
SIMRAD	NSO & NSO EVO2			X					
	NSS & NSS EVO2			X					
	NSE			X					X
	SONICHUB								X
FURUNO	TZTOUCH					X			
	THE NAVNET VX2		X						
	NN3D			X					X (5)
	BLACKBOX KEYBOARD		X						

Note 1: Larger compact flash (CF) cards my work depending on the software version.
Note 2: Software versions 3.10 or lower must use 2-GB SD standard card. Versions 3.20 and higher can use up to a 64 GB (FAT32) SDHC card.
Note 3: Software versions 4.00 or lower must use 2-GB SD standard card. Versions 4.1 and higher can use up to a 64 GB (FAT32) SDHC card.
Note 4: Simrad NSE systems can also use up to a 4-GB USB thumb drive.
Note 5: Furuno Black Box systems use a USB port for chart loading.
Note 6: 64-GB SD or SDXC card formatted to FAT32.
** Garmin GPSMAP 2000 and 3000 systems require a special card reader and chip. Contact your dealer or Garmin customer support.

A card reader that will accommodate a variety of card media types costs about $30. You can buy a standard SD card reader online for under $10. Be sure to buy a card reader that, at a minimum, supports standard SD, HDSC, and SDXC cards.

PS suggests you buy only SanDisk brand cards and readers. Others will work, but chartplotter vendors specify and test their products using the SanDisk brand card. You'll almost always find the best pricing and selection online. We've purchased media cards at the following online retailers: B&H Photo, Amazon, and eBay. When using online stores, look for those that offer free shipping.

MEDIA CARD CARE

Media cards are extremely durable. They can take a 500 Gs of shock, survive 72 hours in fresh water at a depth of 1 meter (IPX7), and take a 15-foot fall with ease. Airport X-ray systems and magnets don't affect them. We've even had some survive a machine wash (not recommended).

The number one reason why a card doesn't work is that its contacts are dirty—or, rarely, completely worn out. The easiest way to clean the contacts is with a Q-Tip, dampened slightly with water. Use pure alcohol, if you need to get grease off. Follow up by polishing with a clean, dry Q-Tip afterward. In a pinch, a pencil eraser can also be used to clean the contacts.

We also recommend storing SD cards in a dry location on the boat, preferably in a container with a silica-gel packet, to keep the contacts from turning green from salt-air exposure.

The cards are hard to label, even with a fine-point, permanent-ink Sharpie. We keep each disk in its own plastic case, and the cases themselves are easily labeled with a Sharpie. The cases cost a couple of dollars online.

UPDATING SOFTWARE

We all know the guy who updated his trusty chartplotter and erased all his hard-won waypoints. You don't want to be that guy.

1. Read the instructions. Download and carefully read the update instructions before you start the software upgrade process, not in the middle of it, when it's too late. Print out a copy of the instructions and take it with you to the boat when you do the upgrade.

2. It's critical that you save all of your data such as waypoints, routes, and tracks on a separate SD card before you do the software update. There can be scenarios where the updated system will require you to do a factory reset as part of the update process, and this will erase all of your data. It's a good idea to save your data first anyway. The back-up process is usually straightforward and described in your device's owner's manual. When in doubt, contact the maker or check its website for technical support.

3. Before doing an update, turn on all equipment linked to the system (including autopilots), if they are of the same brand as the multifunction display. This allows the update of other components that are part of the system.

4. Be patient. Many software updates are approaching 2 gigabytes in size, and updates can take considerable time on some occasions.

5. Never interrupt a software update. If you think something has gone awry, contact the manufacturer's customer support department for assistance. Don't start pushing buttons or remove a memory card during an update, or your operating system may become corrupted. Once the system is corrupted, you'll probably have to send it to the manufacturer for repair—usually at your own expense.

Pelican 3310


Luci Light

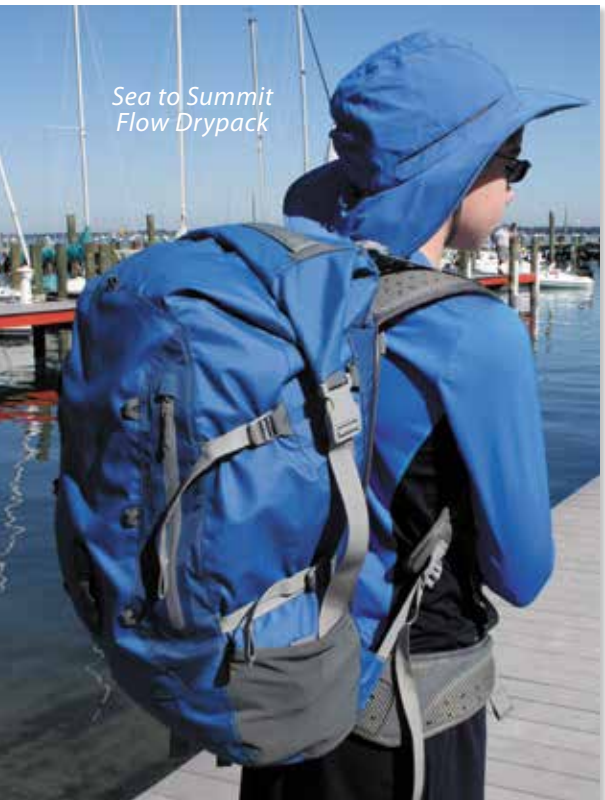
Gear Fit for Summer Sailing

We're just as addicted to being on the water as anyone, but like many of our readers, we also dabble in other activities. For some, sailing is a pathway to their another big passion: travel, exploration, diving, surfing, or simply finding those rare corners of the planet that are truly quiet. For this reason, any product that's useful for one or more of these activities tend to get our attention. Here are some that we've been tinkering with since last autumn, when they first arrived on our desk.

PELICAN 3310

LEDs have virtually revolutionized the world of battery-operated lights, as we saw in our recent tests of LED spotlights (see *PS* January 2012 online) and flashlights (see *PS* September 2007 online). New and more-powerful LED "bulbs" are being developed each year, and battery technology is also progressing. A good example of how quickly the playing field is shifting is illustrated with the new light from Pelican, an innovative company best known for producing the "world's toughest" waterproof cases (see *PS* April 2002 online).

The Pelican 3310 flashlight is the successor to the Pelican 2410, which was our top-rated flashlight in the 2007 test. Since then, Pelican has added photoluminescence (glow-in-the-dark) as an option for several of its lights, including the 2410; this is a handy feature when you're trying to locate the flashlight in a suddenly dark cabin.


Sea to Summit Flow Drypack

Like the 2410, the 3310 is made of rugged, impact-resistant plastic and is waterproof and submersible. It's most noticeable design element is the battery cover, which is on the rear of the housing, instead of the front. It requires a key (attached to its lanyard) or small screwdriver to open.

The 3310 uses just three AA batteries, yet emits a brighter light on the high setting for longer than the 2410, which uses four AA batteries.

Although our testers weren't excited by the added complexity to open the battery compartment, the feature ensured that the compartment was well sealed. Other sensible design details like a three-way, quick-touch switch (low, bright, flashing), and an ergonomic, no-roll design shows Pelican has done its homework.

We ran the flashlight through the same series of tests for brightness, beam quality, waterproofing, and impact resistance as we did the 2007 test lights and compared the glow-in-the-dark performance to glow tape from Glowfast (*www.glowfast.com*). In a nutshell, the 3310 blew the old-school lights away.

Bottom line: If glow-in-the-dark is what attracts you, then just slap some tape on your old light. The real value in the Pelican 3310 is what's inside. For $40 suggested retail, this waterproof light is about as good as it gets.

LUCI LIGHT

In our neck of the waterway, owners of moored sailboats quickly learn that the required all-around light at the masthead doesn't offer the best protection against people who bomb through the anchorage at night. Squishable to about a half-inch, the inflatable, solar-powered Luci Light from MPowerd seemed like just the thing to hang on our backstay or boom to ward off collisions without sucking precious battery power.

After a day of hanging in the sun, the light burned through the night at low power, which was enough to light up the stern; at high power, it provided enough cockpit light to read and play cards. It didn't last all night at high power. But the beach-ball plastic case makes us wonder just how long it would last as a semi-permanent fixture for moored boats.

Bottom line: MPowerd is on to something here, with its collapsible,

solar-powered design. As it is, the easily stowed and portable Luci Light ($15) is fine for a cockpit light and camping, but we'd like to see a more rugged version for marine use.

SEA TO SUMMIT FLOW DRYPACK

We've tried out a variety of drybags in recent years, but none that compare to the Sea to Summit Flow 35L Drypack. The closest we can think of is the Crossbreed 1500 from Seattle Sports (see *PS,* October 2005 online). Based in Australia, Sea to Summit specializes in lightweight outdoor equipment for backpacking, camping, and paddling. The ruggedly built Flow fits the bill for all three activities. With a padded (closed-cell foam) hip-belt and stiffened back support, the pack has enough cushion for multi-day adventurers who have learned to travel light. Our test pack faithfully lugged a tent, sleeping bag, food, and cooking kit on a three-day trek through Olympic National Park in Washington.

Every component on the pack, from the buckles to zippers, is well-engineered to resist corrosion and daily wear. We found it online for $200. Smaller models lacking the padded hip belt are more widely available.

Bottom line: This well-made pack is one of the most versatile we've tested and neatly fits the boat-based explorer's needs. Paddlers may want to check out Sea to Summit's pack/dry bags with removable shoulder straps.

BarZ Tofino

BarZ Floater

Photos courtesy of BarZ

BARZ SUNGLASSES

Our last test of sunglasses (see *PS,* July 2009 online) found that some styles of frames and lenses were better suited for specific tasks like reading water depth on overcast days. Immediately after that article was published, we were flooded with questions about bifocal sunglasses and photochromatic (self-darkening/lightening) lenses. When Australian eyewear company BarZ Optics launched what it claimed was the first photochromatic, floating bifocals, we were intrigued.

We tested the BarZ Tofino (the amber acetate lens model), and the Floater (grey, polycarbonate, photochromatic lens) for basic optical characteristics: light transmission and UV protection. We also compared them in the field to the top picks in our last test. The Tofino ($73) has a common acetate lens with a non-polarized magnification oval inset at the bottom of the lens. This bifocal lens eliminates the "black-out" that occurs when viewing some chartplotters or electronic devices from an angle through polarized lenses. The Floater ($198) has a photochromatic lens; the magnified segment is at the bottom of the lens and is polarized. The Floaters are not immune to "blackout," but the photochromatic effect and bifocal inserts helped make reading our electronics easy. The Floaters were handy during harbor approaches that involved watching depth, checking the plotter, and ducking below for a chart or guide book. For extended time in bright sun, we reached for our favorite pair, which were better at cutting glare.

Bottom line: The Tofinos didn't excite us more than other acetate bifocals, but the versatility of the Floaters convinced that we needed bifocal shades. Fit is especially important for bifocals, so some users may be better served by a local optometrist.

ATN DORCAP

Any tropical sailor can appreciate the ATN Dorcap's mission: increase air flow down below and stay dry when a squall rolls through. Supported by a wire-formed hoop, the Dorcap requires no extra hardware to install. Available in small, medium, and large hatch sizes it easily slips over the hatch. Guys at the corners help it hold its shape and keep it in place, and a buckle/clip assembly lets you narrow the gap in the dorade-like opening with a tug from below.

ATN Dorcap

Ruggedly constructed of Sunbrella, the Dorcap shrugged off a 25-knot squall during our test in the Florida Keys. Throughout the late summer heat and squalls, it kept the V-berth cool and dry. A high-aspect windscoop will funnel more air (especially at the dock) and stores more easily, but the Dorcap pays off on rainy nights on the hook.

Bottom line: At $300, the Dorcap isn't cheap, but it should last at least 10 years. For tropical sailors who value their sleep and have the space to store it, it's a winner.

CONTACTS

ATN INC., 954/584-2477, www.atninc.com

BARZ OPTICS, www.barzoptics.com

MPOWERD, 844/676-9373, www.mpowerd.com

PELICAN, 310/326-4700, www.pelican.com

SEA TO SUMMIT, 303/440-8977, www.seatosummit.com

PS contributor Patrick Childress lost the rig on his Valiant 40 when hidden crevice corrosion in a chainplate led to its failure in the Pacific Ocean. The failure and Childress's repair appeared in the December 2011 issue of Practical Sailor.

Hidden Causes of Rig Failure

Preventing a mast catastrophe can involve some super-sleuthing.

By BRION TOSS

When rigs fail, it is often a spectacular event, precipitated by the sudden breakage of a rig component—a wire, a terminal, or a chainplate, for instance. Because this so often comes as a surprise, and because it has been known to happen even to conscientious sailors who regularly inspect their rigging, it is natural to assume that at least some of the causes must be hard to detect; they must be, to some extent, hidden. And this is true. Ish.

That is, there are lots of places in a rig where corrosion can hide, places that require some effort to get at. We will be looking at some of those places, but as you will see, the word "hidden" can have more than one meaning.

1 PHYSICALLY HIDDEN

This section of the mast was covered by a stainless gooseneck fitting. There was no isolating material between the fitting and the mast. The resulting galvanic corrosion was severe, and the corrosion's byproduct—aluminum oxide—expanded so powerfully that it compressed the mast wall, causing it to buckle inward and tear.

This is the kind of thing that we usually think of when we talk about hidden causes of rig failure: something physically covered that escapes our otherwise vigilant notice. But what really hid this was not knowing that expansion inevitably accompanies corrosion. In addition, removing the plate for inspection would involve removing the boom—a major inconvenience.

Photos by Patrick Childress (top) and Brion Toss

2 HIDDEN BY POOR INSTRUCTIONS

This is the inside of a Sta-Lok fitting. One of the strong points of these and similar fittings, like Hayn's Hi-Mods and Norseman's, is that they can be disassembled for inspection. Had the owners taken advantage of this feature, they could have stopped the corrosion before it reached the stage shown here, by injecting a sufficient amount of sealant (like 3M's 4000) to fill the inside of the terminal.

This prevents the intrusion of both air and water, so that the terminal will not suffer from either crevice corrosion, oxidation, or chloride corrosion. The assembly instructions for this type of terminal are typically incomplete, in at least five languages. One manufacturer told me that the company does not want to make the instructions more complete because they fear people would think the terminals were too difficult to use. Among the instuction's shortfalls is—you guessed it—the amount and type of sealant to be used. As a direct result, this type of terminal suffers from a needlessly high rate of corrosion failure, especially in the tropics.

3 HIDDEN BY SLOTH

Terminal wires are supposed to look like this, not like those in photo No. 2. Above, the cover yarns are formed over the wedge, instead of being bent over and mashed against the body of the terminal. Had the owners of the atrocious terminal (No. 2, left) taken the time to disassemble the terminal, they would have discovered, not only the corrosion, but that whoever assembled it did a truly horrid job.

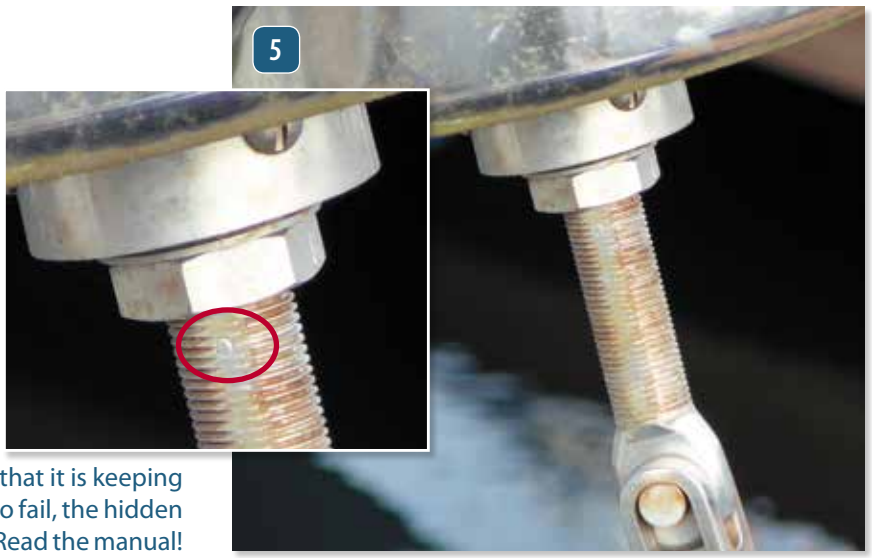
4 HIDDEN UNDERWATER

Another classic example of a hidden cause of rig failure: This bobstay stem fitting is riddled with crevice corrosion, and is suffering from "weld decay," a form of galvanic corrosion. This fitting was under water most of the time, making it inconvenient to get to and inspect.

Similar failures are often experienced with chainplates. In fact, chainplate failure is the single most common cause of dismastings. The problem is that the corrosion nearly always occurs in the deck, or against the outside of the hull, where the metal cannot be inspected without removing the chainplate.

5 HIDDEN IN THE OWNERS MANUAL

Here is the bottom stud on an old-model Harken jib furler. It looks a bit weathered, but there are no problems, either showing or hidden … except that the stamped circle (red oval) is Harken's way of marking the maximum allowable thread extension of this stud fitting. When the furler was new, that circle was painted bright red. This boat has been sailing with the stud extended well past the "do not exceed" limit, meaning that there are too few threads engaged to handle high loads safely. It hasn't stripped and pulled out yet, but it has been too close to the edge, considering that it is keeping the mast out of the cockpit. If this fitting were to fail, the hidden cause would have been hidden in the manual. Read the manual!



6 HIDDEN BY GEOMETRY (PART 1)

In this catamaran martingale installation, the angle of the stay is not lined up with the attachment points of the hardware (long red line). This results in torque (arrows).

7 HIDDEN BY GEOMETRY (PART 2)

The red circles show where torque has caused cracking in the crossbeam welds. The hidden cause here is geometry, hiding in plain sight. It's abstract, but it has real-world effects.

8 HIDDEN IN THE (NEARLY) IMPOSSIBLE HIDING PLACE

This is a top view of the martingale stay turnbuckle, visible in the preceding two photographs (Nos. 6 & 7). Notice that it is fully closed. What are the odds that this stay will have reached a perfect state of tune exactly when the turnbuckle runs out of threads?

There's no corrosion here, no foul leads, no damage to the turnbuckle, but the odds make it extremely likely that the stay is either too slack, or too tight. If the former, the beam will flex upward; if the latter, it will flex down. In either case, one can expect deformation-related damage. And sure enough, on this boat, there were cracked welds at the base of the martingale A-frame strut, in the center of the crossbeam. The hidden factor here was the red-flag anomaly of the closed turnbuckle. Components don't need to be in danger of failing in order to cause a rig failure.

9 HIDDEN IN THE SHADOW

Even if you do take the trouble to go aloft for an inspection, problems won't always be evident. This is a shroud tang, held in place by a throughbolt. Everything looks solid, but what is that "shadow" of unpainted aluminum (circled) above the tang? As it happens, that shadow is where the tang used to be; the through-bolt doesn't have enough bearing surface on the mast wall, and the downward pull of the shroud is slowly tearing a slot into the mast. This results in a slack rig in the short term, and possibly a collapsed mast in the long term. A bushing or other reinforcement will prevent this.

10 HIDDEN ALOFT

Pictured here is a Norseman fitting on a big charter catamaran. Note the diagonal crack right across the top. This was hidden because it was up the mast a ways, and once again, it was inconvenient to inspect. If someone hadn't gone up there for an inspection—and happened to look closely—a dismasting would have been the result. Hidden a little deeper was the fact that the manufacturer of this fitting used a steel alloy that is not compatible with the forging process that formed the eye. The fact that manufacturers do things like this is one of the reasons why regular aloft inspections are so important.

11 HIDDEN BY IGNORANCE

Another hidden cause, and no, it's not that broken toggle. There's no way to miss that. You don't need a trip aloft, or a manual, or a knowledge of trigonometry, or the energy to disassemble something, in order to find the broken toggle, an imminently deadly problem. You just have to pay attention.

Context: This is a boat on which a rig failure resulted in the death of a passenger not very long before this photo was taken. You would think that the crew of this particular boat would be obsessive about rig inspections, would be so hyper-aware of the potential consequences of a rig failure that they would be unable to miss something like this.

Sure, *we* wouldn't let this happen. But before we get to feeling too smug, we need to bear in mind that most "hidden" problems are not hidden behind physical obstructions; they are hidden behind the walls of our ignorance. If we don't comprehend how energy flows through a rig, don't know the properties and characteristics of the materials that the rig comprises, it can be very hard to find things before they fail. We will walk right by scary problems, not because we don't care, but because we don't know, or notice. If you want to know what the worst cause of rig failure is, I can tell you: It is us boat owners.

HIDDEN IN PLAIN SIGHT

12 The owners of this boat got a lovely new Rocna anchor, and it wasn't going to fit on the stem. (This is a common challenge; these are popular anchors, but they do take up a lot of room.) The resulting platform installation was very nicely done—stout, good welds, polished—but there are at least two glaring, dangerous problems hiding in plain sight here. Can you spot them?

Here's one: There is no bobstay. Moving the jibstay out into space creates a lever arm (blue line), with the unopposed vertical component of the jibstay's pull (red line) now focused on the forwardmost fastener holding the platform to the deck. The dotted white line shows where a bobstay might lead.

But remember: There are at least two serious problems here. Can you spot the other one? We'll set aside the advisability of that chain keeper for the anchor. The second problem is another design detail that could tear off the anchor roller.

If you think you know what it is, send your answer to author and rigger Brion Toss , who has offered a free copy of his upcoming book, "Rig Your Boat," to a person (selected randomly) who gets it right. Send your answer to Toss at rigging@briontoss.com.

Although you're unlikely to see many Pacific Seacraft 31s winning races, the cruiser is ideal for couples planning to voyage far afield.

Photo courtesy of Pacific Seacraft, by Bill Kund

Living Small on the Big Sea

Tiny-house movement meets 'luxury' boat in Pacific Seacraft 31.

Readers familiar with the work of William Crealock—the renowned designer of the Crealock 37, the Cabo Rico 34, the Dana 24, and at least 30 other production-built vessels—understand that his designs are steeped in practicality. Crealock famously wrote: "Seaworthiness in a cruising boat has to be the No. 1 consideration. It doesn't matter how cute the boat is if it doesn't get [to the destination] in one piece." And those familiar with his life are aware that his knowledge of sailing wasn't just grounded in the study of design, but also in extensive hands-on experience at sea—an imperative for any designer of boats intended for offshore.

HISTORY

As a young man, Crealock completed his degree in naval architecture and worked in a Glasgow shipyard for several years. Afterward, he spent nearly eight years cruising the Atlantic and Pacific oceans under sail. A portion of that time was invested as first mate and navigator aboard a 110-foot schooner. Though the young Brit cut his teeth in yacht design working on large-scale commercial vessels, his expertise matured during the golden age of fiberglass production boatbuilding—the 1960s—in what was then the industry's epicenter: Southern California.

Because Crealock knew the exigencies of offshore sailing firsthand, he conceived his designs accordingly. The Pacific Seacraft 31 exists in that vein. Introduced in 1987, its heritage can be traced to 1984, when Pacific Seacraft commissioned Crealock to produce a smaller version of his then-popular Crealock 37. Initially, he drew a 34-foot adaptation, but several years later, he condensed the design into the 31-foot package that is reviewed here. (The company did build a full-keel, double-ended 31 model dubbed Mariah from 1977 to 1983, but that was an entirely different boat.)

Production of the Pacific Seacraft 31 ran until 1999, and 79 boats were built. Production resumed in 2002. However, in May 2007—after completing 129 of the 31s—the company filed for bankruptcy. A few months later, the majority of its assets were purchased by Steve Brodie and his father, Reid, of Washington, N.C. The duo moved the tooling for all models except the Dana 24 and the rest of the operation to their homebase across the country via 21 tractor-trailer loads, and began building sailboats under the name Pacific Seacraft.

It's important to note that the Brodies convinced many of the company's key

PROS

- Dodger and bimini keep cockpit well protected from the weather.
- Optional low-maintenance stainless grabrails and an aluminum toerail.
- Companionway protected by beefy hatch and cabin trunk.
- Sidedeck is 12 inches wide at narrowest point.

CONS

- Not enough clearance between winches and lifelines for easily trimming sheets.
- Scuppers in aft corners of footwell allow standing water under power.
- Optional bimini obscures helmsman's view of mainsail.

Photos by Dan Dickison


Well-protected cockpit
Wide sidedecks


Double anchor roller


Optional aluminum toerail
Outboard shrouds


Harken primary winches


Optional saloon-style doors

personnel to make the move East as well, including the overall production manager, the mold shop manager, plumbing, mechanical, and electrical managers, the touchup and detail supervisor, several master carpenters, and skilled tradesmen. According to the company, this cadre of individuals represented hundreds of years of experience building Pacific Seacraft boats.

The boat *PS* tested for this review was hull No. 129, the last one built at the California plant.

DESIGN

Pacific Seacraft's design brief for the 31 was straightforward. This vessel was intended to have all the essential elements to qualify as a "world-voyaging yacht." In fact, those words appeared in the marketing literature that promoted this model upon its introduction. And specifically, Pacific Seacraft intended for the 31 to appeal to cruising couples.

Similar in design to its immediate forebearers, the 31 has a proportionally broader beam and a longer waterline. The intent here was to produce reasonable speed under sail as well as comfortable motion and enhanced handling. The hull begins with a relatively fine, high bow and deep forefoot that extends aft accompanied by a subtly concave sheerline. Beneath its 24-foot, 2-inch waterline, the 31 sports a modified fin keel and a skeg-hung rudder. But the stern section is a definite departure from Crealock's design norm. Instead of the rounded, double-ended configuration seen on the 34 and many of his other designs, the 31 has a broad, flat transom that enables easier stern boarding and allows for a sizeable quarterberth.

The 31 comes in two keel options, a shoal-draft version that draws 4 feet as well as a standard version that draws 4 feet, 11 inches. According to Steve Brodie, "having a shoal-draft option was important, because although we anticipate that these boats will sail in the open ocean, they'll also be used a lot around the southeast Atlantic coast and in the Gulf Coast area. And, it turns out that they're popular in this region."

Aloft, this boat features a single-spreader, extruded aluminum mast supporting a cutter rig and 600 square feet of sail area (though a sloop rig option with 485 square feet is also available). Down below, the company opted for an open interior instead of the privacy afforded by segmented cabins. (Joseph Artese, who designed the interior of the 90-foot sloop *Whitefin*, was commissioned to conceive the 31's layout.) The styling is intentionally contemporary with a simple layout that the marketing literature describes as "versatile."

DECK DETAILS

The boat that *PS* tested was built in 2007 and is one of the few 31s with a Seldén anodized aluminum mast. (Historically, Pacific Seacraft delivered the 31 with powder-coated aluminum spars

The Pacific Seacraft 31 packs a lot into a small space, but the interior is best suited for a couple, unless visitors don't mind the lack of privacy. Corian counters (above) offer an updated look to the compact galley, while tilt-out cabinets (above left) offer a unique organizational approach to nav station odds-and-ends. Testers found engine access, beneath the companionway ladder (at left), to be impressive for such a small space.

Photos by Dan Dickison and Bill Kund (courtesy of Pacific Seacraft)

as standard equipment, a practice the Brodies are continuing.) The in-mast furling aboard our test boat is also not standard.

The boat that *PS* tested also has the optional low-maintenance package, which includes stainless grabrails instead of teak and an aluminum toerail instead of a teak caprail.

Nearly a third of the space on deck is occupied by the cockpit, which despite its low coamings, is well protected by the high cabin trunk, a deep footwell, and an optional dodger. Except for the two-speed, self-tailing Harken 40 primary winches, the coaming isn't encumbered by hardware, affording additional seating in moderate conditions. The 6-foot, 2-inch cockpit seats are sufficiently long for a full-sized adult to stretch out fore and aft, yet they narrow to just 8 inches adjacent the steering pedestal.

Despite the 30-inch, stainless-steel Edson steering wheel and the 12- by 24-inch instrument pod that sits above it (an owner option), the helmsman can easily move forward to tend the halyard tails alongside the companionway. The sightlines forward from the raised helmsman's seat are clear.

Athwartships of the steering pedestal are cubbies recessed into the coaming that are 10 inches deep by 18 inches long and 4 inches high. Protected by a teak fiddle, they're sufficiently sized to keep winch handles or handheld VHFs, etc., handy yet secure.

Beneath the helmsman's seat is a sizeable rear lazarette. Both port and starboard cockpit seats also have locking lids that access additional lazarette storage. On the transom, the owner of our test boat had an anchor roller mounted to port, which is a good feature if it can be placed appropriately to be both out of the way and securely mounted. Headroom beneath the optional bimini that covers the cockpit is a full 6 feet, 4 inches; however, this does obscure the view of the mainsail from the helm.

Embedded in the cockpit sole are 2½-inch scuppers situated in the aft corners of the footwell. The owner of our test boat attested that this positioning comes with one drawback: An inch or two of standing water can accumulate in the forward part of the footwell under power at full throttle.

The companionway is well protected on either side by the cabin trunk and is fitted with a beefy hatch system overhead. The owner of our test boat opted for saloon-style teak doors instead of drop boards, which gave him the option of swapping out screens in the doors for solid panels.

In just 10 seconds, testers were able to get 270 degrees of engine access by simply lifting the companionway ladder and sound-proofed engine housing (far right). Accessing the stuffing box, however, requires removing a berth cushion and small panel (at right).

At the aft end of the bridgedeck, the 31 has a Garhauer traveler that spans 36 inches and is controlled by a 4:1 purchase. Except for Harken winches and Ronstan turning blocks for the halyards and reeflines, most of the sailhandling hardware aboard our test boat was from Garhauer. The mast and boom are Seldén sections, and the boomvang is a Seldén Boomkicker. On new boats, standard hardware is all Harken.

The nonskid in the cockpit footwell and on deck is a raised diamond pattern that provides better grip than recessed grooves. Adjacent the cabintop, the sidedecks are just over 12 inches wide at the narrowest point. Amidships, just inboard of the 4-inch-high bulwark, there are scuppers on either side of the boat that drain overboard (through the deck and hull, and just outboard of those are hawseholes meant for spring lines, yet there were no cleats in that vicinity on the test boat; new PS31s do have midship cleats. The toerail is capped stem to stern with an optional, perforated aluminum strip intended to serve for anchoring snatchblocks, etc.

The chainplates (stainless-steel tangs measuring a quarter inch by 1.5 inches by 12 inches) are affixed outboard to the hull by way of half-inch, stainless-steel bolts run through a full backing plate inside the hull. The position of the chainplates means that the shrouds don't obstruct fore and aft crew movement along the sidedecks. The cabintop is fitted with stainless grabrails on each side, and all of the portlights (five on each side) and their mounting hardware are polished stainless steel.

Both aft pushpit and the forward pulpit are mounted with stainless, hex head No. 12 bolts. The pushpit, which extends nearly 30 inches off the deck, is split into port and starboard sections to allow for a centerline boarding ladder on the transom. The optional bimini is mounted on the upper rail of the pushpit, meaning less hardware mounted to the deck and a cleaner application all around.

The pulpit extends aft just beyond the inner forestay, and its forward legs are integrated into a stout, stainless-steel anchor platform that houses two anchor bow rollers and a terminus for the headstay.

ACCOMMODATIONS

The openness of the interior is augmented by the choice of off-white gelcoat for the fiberglass, complemented by teak drawer and cabinet door faces and trim. The layout offers maximum space for a few individuals. For example, though they lack doors for privacy, both the quarterberth and the V-berth offer 6 feet, 6 inches of length with at least 5 feet of breadth. Standing headroom throughout the cabin is 6 feet, 1 inch. And every light downbelow or on deck is an LED fixture.

Adjacent the companionway, a compact galley sits to port and the head sits to starboard, cordoned off by the vessel's lone interior door. The galley houses a gimbaled, two-burner stove, a double-well, stainless-steel sink, and sufficient storage areas outboard and within the main cabinet to accommodate foodstuffs and cooking implements for a full week on board. The surfaces here are Corian, an owner option.

A 5-cubic-foot icebox sits across the cabin with a teak lid that does double duty as the chart table. Tilt-out compartments on the inboard side of the icebox cabinet accommodate navigation tools and charts. Just outboard of the chart table is the main electrical panel, which is a marvel of organizational simplicity.

The head compartment is a combination of easy-to-clean, gelcoated surfaces complemented by handcrafted teak doors, trim, and a teak shower grate on the sole. There is ample storage here for personal hygiene items and first-aid materials. At the aft end of the compartment is a wet locker accessed by a 16-inch by 20-inch opening covered by louvered teak doors. The commode is fitted with bronze through-hull valves and a bronze base. Ventilation here and throughout the cabin is accomplished by way of seven 10-inch, opening ports. There's also a 20-inch by 20-inch hatch at the forward end of the cabin.

Attention to detail is evident downbelow. The teak joinery is flawless. A sturdy, vinyl headliner has zippered seams to allow access to wiring and deck hardware fasteners. On either side of the cabin are settees that extend under the V-berth when a forward cushion is removed to offer a full 7 feet of length. (Each settee can fitted with lee cloths to serve as a functional seaberth for passagemaking.)

Outboard of each upright settee cushion are storage compartments for

Photos by Dan Dickison

Hand Laid in the USA

Workers at Pacific Seacraft laminate these hulls by hand, using vinylester resin and layers of biaxial fiberglass laid at 45- and 90-degree axes for enhanced multidirectional strength. The decks are cored with balsa wood except for those areas where fasteners pierce through or fixtures are mounted; those spots are cored with either marine plywood, high-density foam, or solid fiberglass. The two-tone deck is accomplished by masking off the nonskid areas in the mold prior to gelcoat application. This yields a very durable surface.

Pacific Seacraft uses 1-inch stainless bolts to attach the lead keel to the bilge. The keel is also set in epoxy and is mated to a very heavily laminated fiberglass keel stub that is integral to the hull. For the hull stem, the company said it uses roughly three times the fiberglass content that other firms use.

For the hull-deck joint on the 31, Brodie's workers utilize a 2½-inch, inward-turning flange on the hull mated to a flange on the deck, and the joint is adhered with 3M 5200 and through-bolted on 6-inch centers with quarter-inch, stainless-steel machine screws. (This method is used on all of the company's models.)

Down below, there are only partial bulkheads, except for the lone partition between the V-berth and the anchor-chain locker forward. These are fabricated from marine plywood sheathed in a teak veneer. A 3-inch, stainless-steel, tubular compression post supports the deck-stepped mast.

Pacific Seacraft boats, now made in North Carolina, are hand-laminated, using layers of biaxial fiberglass and vinylester resin.

Photo courtesy of Pacific Seacraft

bedding or other bulky items. Between the settees, firmly anchored into the keel sump under the teak and holly sole, is a stainless-steel compression post that also supports a unique, centerline saloon table that slides out from beneath the V-berth. Even the cushions are well made, with stainless-steel snaps engineered into a separate outer flap so that they can be more easily attached.

Perhaps the most impressive aspect of the interior is the easy access to the engine compartment for service. In fewer than 10 seconds, you can remove the companionway ladder, tilt open the insulated teak box that surrounds the engine, and have nearly 270 degrees of access. You can check the oil, the impeller, the water, and the wiring harness here, though access to the transmission fluid dipstick is more challenging. Access to the stuffing box requires removing a quarterberth cushion and a small panel beneath it.

PERFORMANCE

The boat that *PS* tested was fitted with a shoal-draft Scheel keel. Aside from draft, the only difference between this model and the conventional, deeper keel is that this version produces a smaller bilge, limiting the size of the fuel tank to five fewer gallons.

Under power with the 30-horsepower Yanmar diesel churning at 2,400 to 2,600 rpms, the sound in the cabin registered an acceptable 90 decibels. At these rpms, in flat water, the boat cruised at 5.3 knots against a slight headwind. The owner told *PS* that the engine typically burns a half-gallon per hour under such conditions. The engine controls are all within easy reach of the helm.

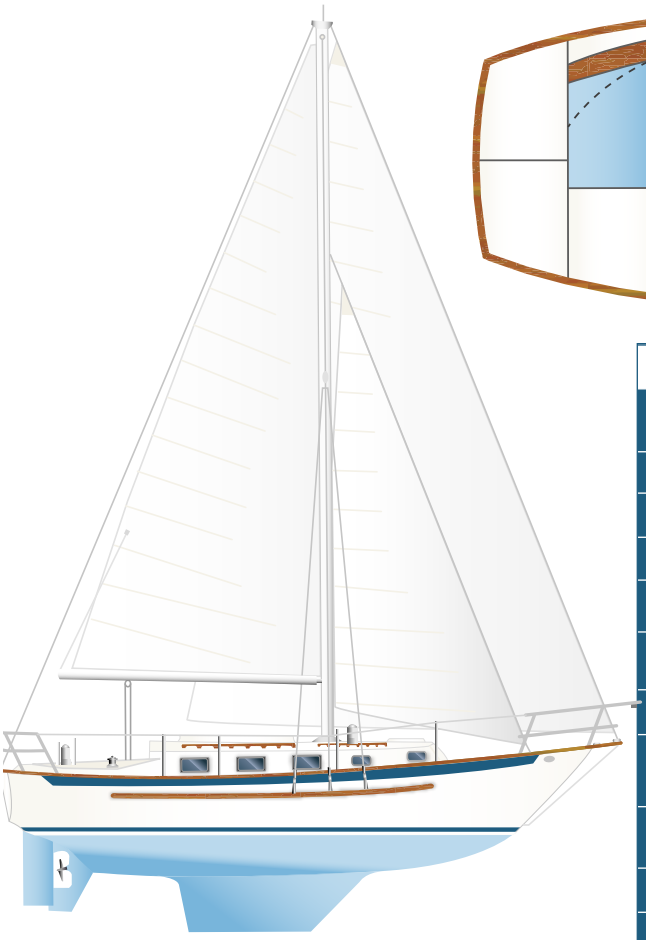
This particular 31 is fitted with an in-mast furling mainsail, giving the boat a working sailplan of 485 square feet. With the full main and headsail close-hauled, and the wind between 10 and 14 knots, the 31 slid along through a 1-foot chop at 3.6 knots. When the wind speed increased to a steady 15 knots, the boat speed increased to 4.2 knots, requiring only minor sail-trim adjustments.

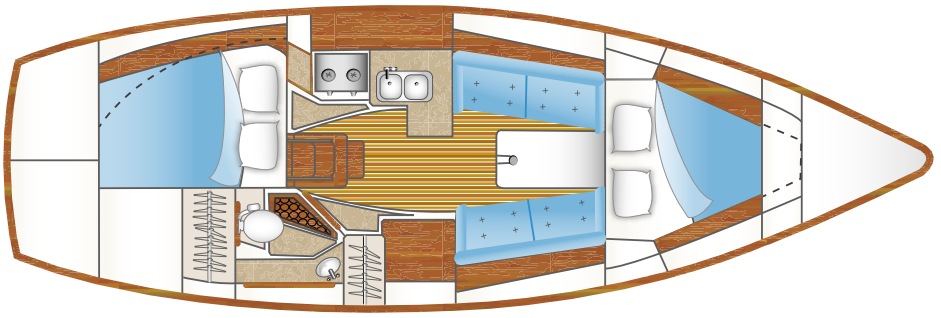
The owner told us that he typically sails upwind with full main and headsail. In winds above 20 knots, he furls the genoa and replaces it with the inner headsail. We took an alternate approach when the winds reached 16 knots and furled the mainsail to 60 percent. That configuration tamed the boat's motion, decreased the heel upwind and enhanced speed by 2/10 to 3/10 of a knot.

The boat responded well to the 30-inch helm and Edson gear-steering system. Despite its lengthy fin keel, the 31 has a relatively tight turning radius and an acceptable amount of headway loss during tacks for cruising. In 18.7 knots of wind and a 1-foot chop, the 31 tacked from a heading of 45 degrees to 115 degrees, coming out of the tack with about 3.8 knots of speed. This is impressive given that this particular boat was fitted with a fixed, 12-inch, three-bladed prop.

Downwind and broad reaching, under the same sail configuration of a partially reefed main and full genoa, the boat moved at 6.7 knots and was very easy to steer. The rig aboard our test boat is fitted with running backstays, which appear to be overkill, in our opinion. However, the owner said they are handy in big blows and at anchor so that the mast won't pump in strong winds.

Underway, the cockpit easily accommodates four people; five would be com-





Illustrations by Regina Gallant

PACIFIC SEACRAFT 31 IN CONTEXT

	PACIFIC SEACRAFT 31	GOZZARD 31	CAPE GEORGE 31	ISLAND PACKET 31
LOA	31′ 10″	31′	31′	31′
LWL	24′ 2″	26′	27′ 6″	27′ 9″
BEAM	9′ 10″	11′	9′ 7″	11′ 7″
DRAFT	4′ 11″ / 4′ shoal	4′ 4″	4′ 6″	4′
DISPLACEMENT	11,000 lbs.	12,000 lbs.	15,835 lbs	11,000 lbs.
BALLAST	4,400 lbs.	4,600 lbs.	7,800 lbs.	4,500 lbs.
SAIL AREA (100% foretriangle)	485 sq. ft. (sloop); 600 sq. ft. (cutter)	607 sq. ft.	634 sq. ft.	530 sq. ft.
ENGINE	Yanmar 27 hp / 30 hp diesel	Westerbeke 35 hp diesel	30 hp diesel	27 hp diesel
WATER	65 gal.	51 gal.	73 gal.	70 gal.
FUEL	30 gal.	38 gal.	40 gal.	25 gal.
SA/D	15.81	18.5	16.15	17.21
D/L	348.22	266.70	339.92	229.80
PRICE *	$79,900	$110,000	$125,000	$54,000

* Average used price (varies greatly)

Pitted against similar cruisers, the Pacific Seacraft 31 closely compares with the full-keel Cape George 31 (see table at right), although its open floor plan (above right) is most similar to that of the Gozzard 31.

fortable as well, but a larger group would push it beyond cozy. The primary winches are close enough to the helm to be tended from there, which is ideal for solo sailing. However, their outboard placement means that rotation of the winch handle is obstructed by the lower lifeline; a problem that needs to be addressed.

CONCLUSION

Boatbuilder Steve Brodie told *PS* that the company's clients rarely compare the Pacific Seacraft 31 to other production-built sailboats of this size and intent. That implies the 31's singularity, which is borne of Crealock's simple outlook on design. When the designer passed away in 2009, Blanca Gonzalez of the San Diego Union-Tribune, wrote in his obituary: "As a child in his native England, if he didn't know the answer on an exam, he just drew a picture of a boat." The straightforward nature of that statement captures the essence of the 31. Despite its diminutive size, this is a capable, offshore cruising vessel with no other pretensions. There are numerous testimonies from owners who have experienced bluewater voyaging aboard their 31s in many parts of the world.

Like those owners, we were impressed. Specifically, we like the 31's open, well-apportioned interior and its easy-to-navigate cockpit and deck. We like the attention to detail evident in its quality of finish. And though we were disappointed by its limited upwind speed in lighter wind ranges, for a 31-footer displacing 11,000 pounds, those speeds aren't unexpected.

Depending upon your perspective, there are just two other conceivable drawbacks. At a base cost of $270,000 for a new model, the 31 is certainly pricey for a boat this size; however, a good-condition used model can be found in the $75,000 to $125,000 range. Also, it would be challenging to accommodate a second couple on board overnight without privacy issues. If you can abide those concerns, and you're in the market for a reliable, compact, offshore vessel, the Pacific Seacraft 31 should be on your short list.

RESOURCES

PACIFIC SEACRAFT, 252/948-1421, www.pacificseacraft.com

PACIFIC SEACRAFT OWNERS, www.pacificseacraftowners.org

ON THE HORIZON
SPECIAL REPORT: BOAT STABILITY
SSB SERIES PART 3
TERMINAL FITTINGS
FUEL STORAGE

Photos by Ralph Naranjo (top) and courtesy of Morten Jensen-Hole

Mounting an SSB Antenna on a Gaff-rig boat

What are installation options when you have no backstay and a steel hull?

Any suggestions for an SSB-radio antenna installation on a 32-foot boat with a gaff rig and no backstay? Also, the hull is mild steel, and the standing rigging is galvanized wire, except the forestays, which are stainless.

Morten Jensen-Hole
Tuatara, Wylo II
Long Island Sound, Conn.

PS ADVISOR

In most cases of a backstay-less boat, we'd recommend a transom-mount whip antenna. However, it looks like *Tuatara* doesn't have much room on her transom for the antenna and the necessary standoff support bracket. If you could make room for a freestanding antenna, that would be ideal.

Although it would not be as efficient as a stern-mounted whip antenna, another possible option would be to install a sort of inverted "V" antenna, following the shrouds and using the mast as the top of the "V." Unless you're well-versed in SSB installations, we suggest asking an installer about this method before deciding on it.

We consulted GAM Electronics' Zachary Figoli (*www.gamelectronicsinc.com*) and Shakespeare Antenna Sales Manager Chris Catoe (*www.shakespeare-marine.com*) about your query. Figoli agreed that rigging an antenna from the shrouds would work, and he explained that some of his customers with catamarans have had success with this method.

Catoe suggested mounting the antenna alongside your cabinhouse, and then using a support bracket mounted higher up on the cabin (3 to 5 feet above the antenna's base if possible).

Avoid running the antenna wire inside the mast. If there are other wires in there (VHF, lights, etc.), we don't think they would play well together. Also, the wire shrouds could act like a faraday cage of sorts, reducing the SSB's RF output power.

GIT ROT TO HALT ROT

I have been looking at a 1981 Landfall 39, a double-ender with teak-on-plywood decks. I am worried about the deck, which appears solid but I already know has some rot in it. Is there a product that will seal the deck until we have time for a proper repair?

Dave and Sandra Brunk
Via email

Once rot gets into the wood, the spores will travel through it. George Buehler (*www.georgebuehler.com*), author of "Buehler's Backyard Boatbuilding," describes using low-cost roofing products for sealing new wooden decks, but it seems unlikely that sealing the teak (easier said than done) is going to buy you much time in this case.

One option he suggested was to remove the teak over the suspected rotten sections, and then stiffen the plywood by using the "drill-and-fill" method described in boat repair books. West System's "Fiberglass Boat Repair and Maintenance" publication (free online) describes this method using its products. Buehler suggests two-part BoatLife Git Rot (*www.boatlife.com*), and we've had good luck with Smith & Co.'s Fill-it Epoxy Filler (*www.smithandcompany.org*). Since removing the teak is half the battle, replacing the plywood here makes more sense to us. There is no easy fix that retains the deck's original structural properties.

Gaff rigs like the one on this 32-foot Wylo II present challenges when mounting an SSB antenna.