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Practical Sailor™

Trimmed for Speed

Safely reaching higher in the pursuit of performance.

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ALSO IN THIS ISSUE

Florida architect Joe King contemplates the rigging that Paul Rudolph employed in his compact "spider house."

Rigged for Small Spaces

After our decade-long sailing sabbatical in the 1990s, my wife Theresa and I washed ashore, nearly broke, and settled into our first apartment. It was a two-room studio across from the hospital in Newport, R.I. with a Murphy bed that, when folded down, took up a huge chunk of the living space. I gasped when the owner showed us the place.

"I know. It's so tiny," she said.

"Very tiny," I agreed.

After my wife and I signed the lease, we had a chuckle. I'd gasped because I was shocked at the amount of space.

The return to the dirt-dwelling life isn't easy. You're accustomed to peace and solitude and waterfront views—a procession of sunrises and sunsets. You can pick your neighbors and move on quickly if you want.

But for me, the most interesting transformation upon returning to land is our relationship with stuff. At sea, we were always paring down what we had to few choice needs. We tried to sustain that same approach when we moved ashore, but the impulse toward simplification eventually weakened. Today, the attic of our new home in Florida holds more stuff than that first apartment.

I was thinking about how a returning cruiser could avoid getting swept back up in the accumulation current when I got a call from architect Joe King from Bradenton, Fla. He was working on a replica of a 1950s-era home designed by the late Paul Rudolph, and the home included some sailboat-like rigging he was trying to sort out. After making a name for himself in Florida, Rudolph went on to serve as chairman of the Yale School of Architecture; the school's main building—a Brutalist icon—bears his name.

King's project was a replica of a home known as the "spider house": a 600-square-foot house owned by a couple who had used it as a winter home for many years. (The original still sits behind the dunes on Sanibel Island, in Southwest Florida.) King will be putting the replica on display at the Ringling Museum in Sarasota, Fla., in the fall.

Effectively a screened-in porch with big doors on all sides that lift open to provide shade or close to offer protection from the driving rain, the sensible little home is a gem. You have to see the video (see link below) to appreciate the design. I was most impressed by the ingenious block-and-tackle assembly used to lift and lower the doors. Rudolph's stint in the Navy clearly left its mark.

As soon as I saw the house, my mind went to work. Here was an elegant solution to the return-to-shore conundrum: a small space equals less stuff. But how to convince Theresa and my sons to start jettisoning belongings, and to squeeze into something so small? King and I talked about trucking the house in pieces to a stretch of turf where it might meld into the landscape—a key aspect of Rudolph's designs. I asked him about building codes. Dropped down, the rugged, double-skinned doors looked like hurricane shutters to me.

"Oh no," he said. "I'm sure this wouldn't meet today's code."

It figures.

Every spider house has a hitch.

For a video on the original "spider house," visit https://goo.gl/gmCZHO online.

An asymmetrical spinnaker helps a McConaghy 38 get the most of a light breeze on the Chesapeake Bay. (Photo by Ralph Naranjo.)

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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@belvoir.com

CUSTOMER SERVICE, WEB, ARTICLE ARCHIVES
P.O. Box 5656
Norwalk, CT 06856
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

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PRACTICAL SAILOR ACCEPTS NO COMMERCIAL ADVERTISING

Readers Loren and Sandy Acker use liquid water treatments to keep their freshwater supply clean aboard their Pacfic Northwest-based Fisher Northeaster 30, Seaweed.

Photo courtesy of Loren and Sandy Acker

CLEANER FRESH WATER

As requested in your July 2015 article, "Keeping Water Clean and Fresh," we are suggesting an evaluation of the two-part liquid Pristine (*www.pristine.ca*) and the Puri Sol water treatments; both use a process utilizing chlorine dioxide for killing bacteria and viruses in contaminated water. This means of sanitizing is purportedly used in hospitals in Europe, and in our experience, it is easy and effective. We have used it in the flexible bladder tanks that were original equipment on our motor-sailer for many years. It is used, apparently, by the military, as well.

Loren and Sandy Acker
Seaweed, Fisher Northeaster 30
Sidney, B.C., Canada

OPERATOR ERROR

In response to your July 2015 article, "Operator Error Strands *Vestas Wind*": You're right, of course, it's operator error when a boat hits a charted reef, particularly one that's part of a 1,000-mile chain. However, this problem is why we've stuck to raster charts as much as possible on our boat. Those vector layers that show clear sailing unless you drill down are just too spooky. We know of several experienced crews that have lost their boats that way.

The obvious cartography solution is to make the top layer show everything that could sink a boat—just never show clear water unless it's really clear. Small reefs would appear disproportionately large, but that's fine with us. If you're anywhere near an obstacle, you would have to drill down to find a way through. It's not simply that this standard would avoid disasters; it would also make the vector charts much less tedious to use. As it is, you really have to go all the way to the lowest level chart on every point of your planned course; otherwise, how do you know it's clear?

Beth Van Zummeren
Via *www.practical-sailor.com*

VHF FIELD REPORT

I think your Standard Horizon HX870 review in the April 2015 issue was pretty good, but it missed a couple of important points.

Volume: My HX870 has noticeably less volume than its predecessor, the HX851 (which I also own). I teach small-boat sailing and am often on the bay using my radio in a Boston Whaler to coordinate with the other instructors in a Sunfish class. The HX851 has plenty of volume, even with the volume turned up only about 80 percent. The HX870's volume is inadequate, even with the volume at 100 percent. This is the most significant flaw. The HX870 is loud enough in a quiet environment ashore, but not on the water.

USB & PC programming: The HX870 has a USB port on the side. You can download programming software for free from Standard Horizon's website and use a standard USB cable to program the radio. This makes it much easier to program in waypoints in advance and to build a directory of MMSI numbers than it was with the HX851. You can also use the software to program in the MMSI for the radio. You only get one chance, and doing it from the PC software was easier.

I'm not wild about the cover for the USB port, but Standard Horizon (SH) guarantees the watertight integrity of the radio, so presumably they have done their homework.

Power button: The HX870 has the power button immediately above the push-to-talk (PTT) button. More than once, I have grabbed the radio and pressed the PTT button only to find I had actually turned the radio off. This is a problem. SH goofed on this design, in my opinion. The HX851's power button is more sensibly placed.

Manual: Some parts of the manual merely mention menu choices, without ever explaining them. Both manuals are about the same.

Battery: The chart in the April issue says the battery in the HX851 is not user replaceable. The battery is replaceable. Both radios come with a rechargeable battery as well as a battery tray that will take AA batteries. You can buy replacement batteries. The battery snaps in and out with no fuss.

DSC distress button: The HX851's distress button is protected by a flexible, orange rubber flap. The HX870 has a spring-loaded, plastic flip cover. I'm a bit worried that it might be possible to catch the cover on the HX870 and break it off. As *PS* noted, it looks like a more fragile design.

Resources for Boat Buyers

It seems many of us are always "shopping" for the next boat, or our *forever* boat. Some of us are simply window-shoppers, content with browsing boat sale websites and dreaming of a longer waterline or less brightwork. But if you're a more serious shopper, here are some *Practical Sailor* archive articles we suggest checking out.

NEW BOAT SHOPPING

The *PS* archive includes dozens and dozens of sailboat reviews, from trailersailers and small cats to racer-cruisers and bluewater voyaging boats built for a family of four. You can search the reviews using the alphabetical index link under the "Sailboat Reviews" tab on the homepage. Also the two-volume ebook series "Entry-level Cruiser-Racer" is a compilation of boat reviews of popular racing-cruising boats; you can buy it in our online bookstore.

If you're planning to carry out a preliminary boat survey—or just want to be well-versed when you go shopping—read our do-it-yourself survey checklist for boatbuyers in the June 2012 issue. Another must-read resource is "A Sailor's Guide to Marine Insurance," which was published in the October 2012 issue. New boatowners would also be well-served by investing in any of the resource books in our online bookstore, especially Don Casey's "This Old Boat," the marine maintenance bible, and the "Boatowners Illustrated Electrical Handbook," by Charlie Wing. On the fence about making that big purchase? Consider a peer-to-peer boat rental (see *PS* July 2015 online) or fractional boat ownership (see *PS* July 2006).

GALLEY OUTFITTING

Before you outfit your galley for cruising—or even weekend sailing—be sure to read these performance tests and long-term product reviews of galley tools. For those who need quick-fix dinners that can basically cook themselves while you're on watch (or enjoying cocktail hour), you'll find our report on pressure cookers in the December 2010 issue and thermal cookers in the September 2012.

If you have more time—and more room—for meal-making and are in the market for a galley oven-range combo, you'll find our latest test on those in the July 2007 issue, along with an update on our test of small stoves. Two other items we consider cruising-galley staples are the coffeemaker and nesting cookware. In the January 2014 issue, we looked at multiple ways of brewing the best onboard java, and testers put nesting cookware sets through their paces in the April 2009 issue.

Size: The HX870 is only marginally smaller than the HX851, but somehow feels and looks much smaller.

DSC test calls: Both the HX851 and the HX870 support the DSC test-call feature. This lets you make a call to an MMSI number that is designated as a "test." Every weekend I'm on the water, I do a DSC test call to the local Coast Guard station. When you do the test call, your radio "pings" the station you are calling with a signal tagged as a test call. The receiving station sends an acknowledgement signal back; all of this is automated. Doing a DSC test call assures me that if I need to whistle up the Coast Guard, all is well.

Robert Rice
Girl Scout Mariner sailing program
Houston, Texas

WHERE'S THE LETONKINOIS?

I've enjoyed your magazine for several years now and have found your varnish tests especially useful. I own a prewar Ed Monk Sr. cruiser with "acres" of brightwork. Pettit's Flagship and Captains have been my basic varnishes, but I also use Le Tonkinois for some things.

I'm wondering why Le Tonkinois (original or No. 1) was not included in this current round of tests (see *PS* June 2015 online).

Also, I've heard that the Fine Paints of Europe (FPE) Marine Yacht Varnish is something special. Have you ever looked at it? Their paint is excellent, but they say their varnish is a real standout.

John Lebens
Sue Ellen, Ed Monk Sr. cruiser
Portland, Ore.

Not too long ago we tested three Le Tonkinois products—Le Tonkinois Vernis (original), Le Tonkinois No. 1, and the teak sealer Huiles Bio Impression, which we also tested with an over-coat of Vernis (original). The original formula was among our recommended products after two years, and the sealer overcoated with the Vernis finished slightly behind the Interlux

Photos by Bill Kund and Jonathan Neeves

Rigging Quiz Answered

In the May 2015 article "Hidden Causes of Rig Failure," the author, renowned rigger Brion Toss, offered a prize to the *Practical Sailor* reader who correctly identified what was wrong with the bow-roller featured in photo number 12 (photo at right), which appeared on page 25. The prize went to *PS* subscriber Capt. Bruce Stewart, of Ithaca, N.Y.

Toss pulled Stewart's name from a hat filled with the names of all the respondents who supplied a correct answer. Stewart, along with the majority of the entrants, noted the lack of lateral support for the "bowsprit" (red line), in addition to the lack of a bobstay (white dotted line) to handle vertical loads. A sizeable portion of the jibstay load, especially when on the wind, is expressed laterally, and this would put excess strain on the forwardmost deck fastener (blue circle). In addition, the attachment of the jibstay to the platform is not toggled, so there is a tremendous torque load delivered to the deck fasteners. For his wisdom (and luck), Stewart will receive a copy of Toss' forthcoming book, "Rig Your Boat."

Sikkens Natural Cetol overcoated with Cetol Marine Gloss. The Bio Impressions sealer initially rated well, but did not last long outdoors. (The maker does not recommend the sealer alone for exterior wood.) For a full report on Le Tonkinois products' performance in our tests, see the April 2008, January 2010 and September 2011 issues online. We haven't tested the FPE varnish before, but we'll add it and the Le Tonkinois products—along with a few other test latecomers—to our ongoing wood finish test; look for a test update in an upcoming issue.

DIY MEDICAL KITS

I read with interest the "Creating a Custom Med Kit" article (see *PS* July 2014 online). While creating your own kit and planning to use onboard resources is far cheaper than the off-the-shelf kits, I do have to take some issue with your recommendations.

The creation of an onboard medical kit at the outset can seem very simple, but actually can be complicated, depending on what problems a crew can handle. In developing a kit, there are several issues that really need to be addressed before even deciding on what to create. First and foremost, the length of the trip and time to medical care will determine to a fair extent the supplies and training needed. Secondly, plans should look first at the low-probability and high-risk events that could occur, which left untreated would end in severe morbidity or death, and then the potentially minor and common issues seen on board.

The longer the trip and the increased time to medical care will increase the complexity and cost of any medical kit. Besides having all crew medications, the person in charge should talk with their own physician to discuss what is feasible to treat.

For high-risk events such as a heart attack, stroke, etc., there is not much a crew can do; maybe give an aspirin, but fast transport to treatment is needed. For trauma, such as major bleeding, basic supplies and a commercial tourniquet is suggested. Creating a tourniquet out of a belt or other objects will cause more injury, might not work, and could cause loss of limb. In preparing a kit, a commercial tourniquet is preferable. If a significant event occurs that results in severe blood loss, shock, or loss of an airway, there is not much that can be done, again except for fast transport. Finally, anaphylaxis is a severe life-threatening allergic reaction. Time is essential. Having an Epi-pen, Prednisone and Diphenhydramine can be lifesaving.

Common, low-risk and frequent events such as contusions, abrasions, and minor lacerations require basic first-aid supplies coupled with a skin adhesive, steri-strips, etc. I would not recommend suturing unless trained in it. Suturing is not difficult, but on a bouncing boat, it is more difficult. Those not trained to provide anesthesia could use too much anesthetic, which can be toxic to the patient. Staples are much easier and can be done without anesthesia for small to medium lacerations.

Another common issue is seasickness. Prolonged vomiting can cause electrolyte abnormalities, not to mention significant dehydration. For on-

Reader John Lebens uses Pettit Captains and Flagship varnish on his Ed Monk Sr. cruiser, Sue Ellen.

Photos by Brion Toss and courtesy of John Lebens

Water Filter Installation

One of the simplest ways to improve the lot of the crew aboard your boat is to install a water filter or water purifier. We installed one aboard our test boat in 2013 (see *PS*, October 2013 issue) and have been enjoying a bottled-water taste without the bottles ever since.

The model we installed was the Nature Pure QC2 Point-of-Use Drinking Water Purifier, an extension of General Ecology's Seagull line of filters. General Ecology (*www.generalecology.com*) is the maker of the familiar Seagull filters which sell for around $600. The Nature Pure QC2 offers handy new features and is less expensive ($355) than the Seagull, although it is still more expensive than the top-rated filters featured on page 18 of this issue. The photos here offer an example of how easy it is to install a water filter at the tap.

1

2

3

4

Photos by Frank Lanier

1. Installing the Nature Pure QC2 was simple and straightforward. Here, we used the handy installation template to mark the location of the new faucet

2. Seagull's QC2 (Quick Change) system has a disposable, external canister rather than an internal cartridge. The canister screws into the bottom of a threaded fitting. It has an inlet and outlet at its top and a non-removable bracket at the back, which allows the unit to be mounted on most any vertical surface. You install it inline, after the pump, of course.

3. The threaded fitting also has a "Sanitary By-pass Connector" (black knob in photo) which is simply a threaded plug that you can screw into the canister port, allowing you to use the freshwater system with the canister removed. When not in use, the plug screws into a holder (as shown).

4. Once the deed is done, all that's left is to enjoy purified water with the turn of the tap.

board use, remedies include Odansetron, which is very inexpensive and great for vomiting, but its effectiveness in seasickness is questioned. Prevention is key, but if it occurs, having two different medications on board, both oral and suppository, can provide significant relief and hopefully prevent hospitalization.

In reviewing your recommendations on medications, there is a lot of redundancy, and it can be made simpler. Antibiotics for short trips are probably not worth the effort. If insistent, Keflex, Bactrim, and Doxycycline would provide coverage for most one would consider treating. The Medrol dose pack is not recommended; it is very expensive and not needed. Prednisone is more cost effective, coupled with the patient's own medication. For allergic reactions, consider Prednisone, Diphenhydramine, and Zantac. Also I would recommend carrying an Epi-Pen on board; while very expensive without insurance, it just is expensive with it.

Finally, I definitely recommend that all sailors take a first-aid course as well as CPR.

It is best to keep any kit simple, use what is on board, and think of the common minor and severe rare events that the crew should be prepared for.

My background: I am board certified in Emergency Medicine and Emergency Medical Services; I'm also trained in wilderness search and rescue. I have been an active sailor and racer since 1967—from racing Lasers to my current Beneteau First 38s5, including offshore trips and long-distance races such as the Port Huron Mackinac Race.

Marc S Rosenthal
PhD, DO, FACEP
Emergency Physician, Medical Physicist
Stargazer, 1993 Beneteau First 38s5

CORRECTION

The phone number for Signature Finish listed in the June 2015 article on exterior varnish was incorrect. The correct number is 772/287-6077.

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.

Anchor Shackles: The $15 Insurance Policy

Pairing a small-diameter chain with a big anchor often requires using two shackles. This setup shows (from left) a 56-pound (25-kilogram) Manson Ray anchor, a 1/2-inch Titan D shackle, a 3/8-inch Titan bow shackle, and 10-millimeter G30 chain.

Photos by Jonathan Neeves

Limit your shackle search to load-rated, brand-name products.

We're always amazed how a sailor can spend months agonizing and wringing his hands over which anchor to purchase, and then, when he finally shells out $700 or much more for the anchor, he'll attach it to a shackle that has no business being on a boat. We've plowed through the topic of shackles in several recent issues (mainsail shackles, see *PS* September 2014 online; snap shackles, see July 2014 online), but we haven't looked specifically at anchor shackles for more than a decade. Choosing a properly sized, high-quality shackle is important, but it's also essential to be familiar with proper use.

For this comparison, we focused on galvanized shackles of proven styles, from established manufacturers. We also explored some of the alternatives to conventional galvanized "bow" shackles, a topic we'll expand on in a future issue.

The typical anchor shackle is a galvanized bow shackle, with the bow (not the pin) passing through the oversized slot in the anchor shank. In some cases, a "D" shackle is used, but only when there is no slot in the shank. Examples of slot-less anchors include the CQR, Guardian, and the Manson Ray.

By definition, the shackle must have an eye small enough to fit through the slot, and must have a shackle pin small enough to fit into the link in the chain. Even though it's restricted by size, it should be stronger than the chain.

Finding shackles strong enough to fit "high-tensile" G43 chain outside America is difficult. And it is impossible to find a shackle that will match G70 chain. If you find a shackle to fit the link and anchor slot, it is either not made of galvanized steel and/or it has never been tested in a marine environment. (For a more detailed discussion of chain grades, see "Making Sense of Chain Standards," *PS* June 2014 online.)

Reputable galvanized bow shackles today are forged and made from high-strength alloy steel. Bow anchor shackles also have a narrow mouth, to compensate for the high loads at the pin. The narrow mouth restricts the thickness of the shank to which they will fit. Shackles come in a wide range of designs, but the most basic design is a simple bow of alloyed steel with a threaded clevis pin.

It is essential that shackle pins are secured. Commonly, screw pins are secured with mousing wire. You can also use a thread sealant like Loctite (numbers 243, 242, 222, 638, 680, and 609). Loctite is fairly reliable, but you should plan to regularly re-apply the sealant.

WHAT WE TESTED

Shackles are generally available in two grades: Grade A and the stronger Grade B. In the 3/8-inch shackle size, Grade B shackles have a working load limit of two tons; the Grade A working load limit (WLL) is half of that. For this report, we focused on the higher-load Grade B shackles. There are a large number of established manufacturers of galvanized bow shackles, but we limited our evaluation to Peerless, Campbell, Crosby, and Canada Metals Pacific (CMP)/Titan as these are the established names in the industry. We did not look at cheap shackles of unknown origins, or those that bore the scent of counterfeiting, a known problem in this industry.

Crosby is arguably the most familiar American shackle manufacturer. Based in Tulsa, Okla., the company has been making shackles for over six decades and has a design for every conceivable application and environment. Crosby makes other components for lifting, but among sailors, it is best known for its shackles. They have an enviable

As the hydraulic ram increased tension on each shackle, testers recorded loads and noted any deformation.

Pull it Until it Breaks

All testing was carried out at an approved test facility in Newcastle, Australia: J.L. Robertsons, which is adjacent to one of Australia's large coal-mining areas. The test rig is used to certify lifting components for the local mining industry on a daily basis. The facility can test up to 95 tons, far more than we require. This is the same facility where we tested all of our anchor chains. (See *PS* June 2014, November 2014, January 2015, and March 2015 online.)

The rig is fairly simple. A ram loads the components, and a load cell tracks the increasing load versus deformation. One of each shackle was tested in exactly the same way, one after the other. Testing just one unit, as we did, is of limited statistical value, but we will be testing more units in the future.

Two notes about safety factors and ratings. A safety factor, as we described in our previous study of chains (see *PS* June 2014 online), is the ratio between what would be considered the safe working load limit (SWL or WLL) and the minimum tensile stress (MTS), also called minimum break stress (MBS). MTS is the minimum point at which a shackle or link can be expected to fail. It is mathematically derived, based on the type of steel and structural dimensions; WLL is a fraction of MTS. Ultimate tensile strength (UTS) is the breaking point based on actual data, and manufacturers are supposed to batch test to ensure UTS is higher than MTS. Finally, there is proof test, which is two times the working load limit and should result in no deformation. Crosby, Campbell, and Peerless proof test every shackle they make.

When assembling an anchor rode, use the working load limits for matching shackles and chain, but be aware of the different safety factor being applied. (See *PS* Advisor, August 2015.) The safety factors for the shackles we tested range from 4.5:1 to 6:1; so a shackle with a slightly lower working load limit might actually be the stronger one. To further confuse the issue, some shackles are rated in metric tons, others in imperial or short tons—even when the sizes are advertised in inches.

reputation for quality, and their G-209A forged, alloy, quench and tempered, galvanized shackles have become the standard anchor shackle in the U.S.

Campbell is a part of Apex Tools and is another significant player in the anchor-chain industry. The company has a range of galvanized bow shackles ideal for anchor rode.

Van Beest is a Dutch manufacturer that has been supplying components to the lifting industry for almost a century. It is well known across Europe and parts of Asia for its green pin shackles, but it also supplies G8 and G10 lifting components under the Excel brand from its French factory.

We did not have access to Van Beest shackles for testing, but it is worth noting that the maker's 10-millimeter green pin bow shackle has an oversized 11-millimeter pin with a working load limit of 1,000 kilograms (2,204 pounds).

Canada Metals Pacific is best known in the marine industry for its range of Martyr-brand sacrificial anodes and as licensee for the Rocna anchor. It also licenses the Vulcan anchor, and makes a range of anchor chain in China under their Titan brand. CMP has recently introduced a range of Titan shackles.

There are several other well-known international companies that supply the global market in lifting equipment and make shackles: Columbus MacKinnon, Gunnebo, Rud, Pewag, etc. These are reputable sources, but because of time constraints, and because these brands are not so widely marketed to boaters, we did not include them in this test.

There are alternatives to shackles. Some regard hammerlock chain connectors as an option (see photo page 31), but we have some concern about the abrasion and corrosion resistance of the very thin, high-tensile pin that holds the assembly together. Boats in New Zealand often use an Omega link. The Italian chain-maker Maggi now supplies a galvanized Omega link to be used with its high-tensile G70 chains, but we were not able to acquire one for testing.

As an experiment, we took some 6-millimeter G80 Omega connectors made in France by Van Beest and had them coated using the Armorgalv process (see *PS* March 2015 online). These also were included in this test. Another option, again from the lifting industry, are G80 pear shackles. These are widely used in New Zealand, and we hope to test some in the future.

Our investigation into alternative designs was prompted by a common question: How does one connect a smaller-diameter, higher-tensile chain (G70 is commonly cited) to an appropriately sized anchor without sacrificing strength at the shackle. For a number of reasons, we strongly prefer conventional G30 or G43 chain over G70. (See "Looking into the High-test Myth," *PS* June 2014 online.)

For details on our test protocol, see "How We Tested."

WHAT WE FOUND

All of the shackles and the Omega link failed in the same way. The clevis pins sheared. Some shackles deformed, but it was always the pin that failed in our

PS VALUE GUIDE ANCHOR SHACKLES

BRAND	MODEL	MADE IN	SIZE	SUITS CHAIN	WLL	SAFETY FACTOR	MIN. BREAKING STRENGTH	UTS (AS TESTED)
CAMPBELL A419 G ✓	Orange pin	USA	3/8 inch - 10 mm	5/16 inch or larger	4,400 lbs.	5 to 1	22,000 lbs.	21,016 lbs.
CMP/TITAN $	Yellow pin	China	3/8 inch - 10 mm	5/16 inch or larger	2,200 lbs.	6 to 1	13,200 lbs.	18,885 lbs.
CMP/TITAN	Black pin	China	3/8 inch - 10 mm	5/16 inch or larger	4,400 lbs.	5 to 1	22,000 lbs.	19,036 lbs.
CROSBY G209 A ✓	Silver pin	USA	3/8 inch - 10 mm	5/16 inch or larger	4,400 lbs.	4.5 to 1	19,800 lbs.	19,905 lbs.
PEERLESS ★	Blue pin	USA	1/4 inch - 6.3 mm	1/4 inch or larger	1,500 lbs.	6 to 1	9,000 lbs.	9,800 lbs.
PEERLESS ★	Blue pin	USA	3/8 inch - 10 mm	5/16 inch or larger	4,000 lbs.	6 to 1	24,000 lbs.	Not tested
VAN BEEST EXCEL	Omega G80	France	6 mm - 1/4 inch	6 mm (not larger)	2,450 lbs.	4 to 1	9,850 lbs.	9,397 lbs.
VAN BEEST EXCEL	Omega G80	France	10 mm - 3/8 inch	10 mm (not larger)	7,040 lbs.	4 to 1	28,160 lbs.	Not tested

★ Best Choice ✓ Recommended $ Budget Buy

PS VALUE GUIDE SHORT-LINK CHAIN

BRAND	MANUFACTURER	SIZE	SAFETY FACTOR	UTS (AS TESTED)
AVERAGE	Any	5/16th /8 mm G30	4 to 1	9,000 lbs.
AVERAGE	Any	8 mm G40	4 to 1	9,300 lbs.
AVERAGE	Any	5/16th G43	3 to 1	12,000 lbs.
AVERAGE	Any	5/16th / 8 mm G70	3 to 1 (Maggi 5 to 1)	15,000 lbs.
WEST MARINE	Peerless/Acco	1/4 inch G70	3 to 1	9,450 lbs.
GUNNEBO	Gunnebo	6 mm G80	4 to 1	9,963 lbs. (trial Armorgalv coated)

tests. Most of the shackle pins sheared at the threads.

It is important to note that we tested the shackles while they were perfectly aligned with the load; and the point of contact with the shackle was a rounded section. In the real world, a shackle might be side-loaded, and the slot in an anchor shank might impart a much higher point-load on the shackle. In short, the failure loads that we recorded were best-case scenarios.

All of the galvanized shackles we tested were effectively the same size (except the quarter-inch Peer-Lift); all were classed as 3/8-inch or 10-millimeter shackles (size is dictated by the nominal diameter of the bow). This means that all had 7/16-inch, 11-millimeter pins—still small enough to fit into a 5/16-inch short-link chain. Some of the pins did not fit an 8-millimeter short link metric chain (which would have a 10 millimeter hole in the link).

The bottom line? Check fit before you buy. The dimensions of chains with the same nominal size can vary, so you may have to cut a link off and try it with your anchor to find the right match.

The 3/8-inch shackles easily fit into a wide range of 35- to 45-pound anchors that are compatible with a 5/16-inch or 8-millimeter chain. If you use an oversized anchor, you will often find that the shackle you need to fit that anchor will not fit the chain, in which case, you will need two shackles, a large one for the anchor and a smaller one for the chain. In such instances, you might also find that the larger shackle does not fit the bow roller, especially on modern sailboats, which seem to be fitted with smaller and more narrow bow rollers these days.

The accompanying table gives the average results in our testing of 5/16-inch or 8-millimeter short-link chain. (See *PS* January 2015 online.) Broadly speaking, we found the following ultimate tensile stress failures (actual breaking strength) for chain, by grade: G30, 9,000 pounds; G40, 9,300 pounds; G43, 12,000 pounds; and G70, about 15,000 pounds.

CAMPBELL

Campbell has an extensive range of drop-forged, carbon steel, Grade A shackles, and a very limited range of galvanized, alloy steel, Grade B shackles. The stronger, Grade B shackles are available only in sizes starting at 3/8-inch, increasing to half-inch, and then increasing in quarter-inch increments. The Grade B shackles have an orange pin.

Pin Proves to be Weak Link in Shackles

Ultimately all of the shackles in our test failed in the same place, at the shackle pin. Some shackles deformed before failing, others held their shape until after the shackle pin failed.

The failures almost always occurred at the pin threads, where the diameter is reduced. The failures occurred on captive threads and the exposed threads with equal frequency, although since the threads are a weak point it would make sense to seat the pins as snugly as possible.

1

2

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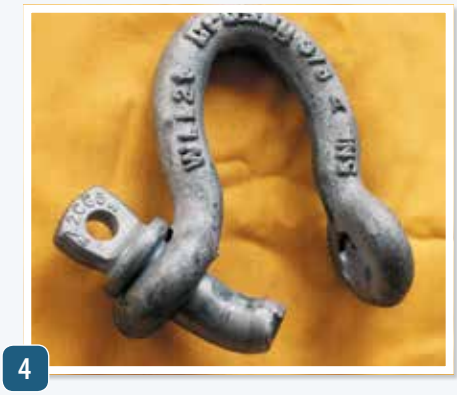


4

1. Two identical Grade B 3/8-inch Campbell shackles with orange pins; the left shackle was not tested. The right shackle's failure was caused by the clevis pin shearing at the thread/eye interface, where the clevis pin is at its weakest. There is not a massive amount of deformation of the bow of the shackle and is minimal pin bending.

2. This CMP/Titan 3/8-inch, yellow pin, Grade A shackle failed when the clevis pin sheared at the thread. Note that though the pin is relatively straight, the bow is quite elongated.

3. This unrated shackle failed in use. It was sensibly moused, but the pin simply pulled out of the thread. The shackle had been incorrectly installed with the pin through the anchor shank. The shackle was then sideloaded, and the pin pulled out of the thread eye. The shackle is likely a soft steel, and the thread simply deformed, a common failure with stainless fittings.

4. This Crosby silver pin, Grade B, 3/8-inch shackle failed when the pin sheared at the thread. The bow has also noticeably elongated and the pin bent. If your shackle loses shape and the pin deforms, it means that it has been overstressed and should be retired. Bending a Grade B shackle in use would be very unusual; check chain link dimensions.

Campbell's 3/8-inch shackle has a rated working load of 4,400 pounds. The makers specify a 5:1 safety factor; this would give it a minimum break load of 22,000 pounds. In our testing, we found the ultimate tensile stress to be slightly less than the rating. The pin sheared at the thread at 21,016 pounds. There was minimal deformation of the shackle itself.

Bottom line: Campbell's safety factor appears to be slightly optimistic, but this was, overall, the strongest shackle in our test. It's Recommended.

CROSBY

Crosby anchor shackles are recognizable by a silver pin. The size range begins at 3/8 inch, moves up to 7/16 inch, and then increases in increments of 1/8 inch thereafter. Crosby's range of shackles is big, too big to be used with quarter-inch or 6-millimeter chain, or anything smaller, including the 8-millimeter Maggi G70. Crosby shackles are rated by metric ton, with a safety factor of 4.5:1.

The 3/8-inch shackle we tested had a rated working load limit of 4,400 pounds with a 4.5:1 safety factor. This gives it a minimum break load of 19,800 pounds. In our testing, the ultimate tensile stress was 19,905 pounds, slightly above its rating. The failure was at the thread; the pin sheared. Testers noted some deformation in the eye of the shackle where the pin seats.

Bottom line: Crosby is a recognized leader in this field and fared well in our test. It's Recommended.

PEERLESS

Peerless, now part of the Japanese Kito Corp., is the United States' biggest chain manufacturer and best-known supplier of anchor chain, primarily through its Acco brand. It offers a complete cross-section of imperially sized chain, BBB, G30, G43, and G70; and recently, it introduced metric G40 and G70.

It is also a major player in the lifting industry. Peerless makes a range of galvanized shackles for lifting, known as the Peer-Lift line, which it also des-

This Manson Supreme (above) will accept a bow shackle, but it is incorrectly attached to the chain with a rated D shackle. The anchor at left is using a correctly installed bow shackle that needs to be moused.

ignates for marine use.

The Peer-Lift products are forged alloy, galvanized, and individually proof-tested to two-times working load. The size range is extensive, from 3/16-inch to half-inch in 1/16-inch increments, and then increasing in 1/8-inch increments to sizes larger than 1 inch. They have a shackle size to fit most situations. The shackles are differentiated from other suppliers by a blue pin. They are well suited as anchor shackles

The Peer-Lift quarter-inch, Grade B, shackle we tested had a rated working load limit of 1,500 pounds with a 6:1 safety factor. This gives it a minimum breaking limit of 9,000 pounds. In our test, the shackle exceeded its load limit by almost 10 percent, failing at 9,800 pounds. The failure was at the thread; the pin sheared.

Bottom line: Peerless, which also performed well in our chain test, exceeded all expectations in this evaluation. Recommended.

CANADA METALS PACIFIC

CMP has recently introduced a range of shackles with a yellow or black pin. The yellow pin shackles are Grade A, and black pin shackles are Grade B. Canada Metals Pacific rates its shackles in metric tons. The CMP/Titan yellow-pin, 3/8-inch shackle we tested had a rated working load limit of 2,200 pounds with a 6:1 safety factor. This gave it a minimum breaking load of 13,200 pounds. Its actual ultimate tensile stress was 18,885 pounds. In our test, failure was at the thread; the pin sheared.

The Titan black pin 3/8-inch shackle we tested had a working load limit of 4,400 pounds with a 5:1 safety factor. This gave it a minimum breaking load of 22,000 pounds. It's actual ultimate tensile stress was 19,036 pounds. Informed of this result, CMP said that although it always carries out internal shackle testing, it plans to have independent tests of its shackles carried out to ensure they meet its specifications.

Bottom line: Our Budget Buy. Stick with CMP's yellow-pin shackles, which offer a significant margin for error; be aware that there several other "yellow-pin" shackles on the market. Look for the CMP logo.

VAN BEEST EXCEL OMEGA LINK

This was a G80, 6-millimeter (7/32-inch) link that we had Armorgalv coated. It will fit a 6-millimeter, short-link chain. The working load limit is 2,450 pounds, and it is made to a 4:1 safety factor, providing a minimum breaking load of 9,850 pounds. Maggi provides this connector for boaters who want to downsize their chain to G70 in order to save weight, or carry a longer rode. We do not know what grade steel Maggi uses for these link connectors nor does it carry an certified load rating.

The actual ultimate tensile stress of the Van Beest Omega unit was 9,397 pounds. This is below the specified minimal testing strength (untreated), but this was expected, since the Armorgalv coating process degrades strength. The clevis pin failed; however, it is worth noting that we did not secure the clevis pin with the high-tensile locking pins that Van Beest supplies for this purpose.

Bottom line: A galvanized Omega shackle is hard to find in the U.S. If you are interested in pursuing this option, contact Spencer Industries (see "Contacts" box), which licenses the Armorgalv process in the U.S. This approach seems like a possible solution for boaters who want to switch to G70 chain.

CONCLUSION

The Peerless and Crosby shackles all met or exceeded minimum specifications, and the Campbell shackle fell short by only a whisker. American-made shackles appear reliable.

Visually, we could not differentiate between the two grades of CMP shackles, except for the color of the pin, the embossed rating on the bow, and the price. The yellow pin model was quite impressive; the black pin variety fell short and CMP is looking into this.

High-tensile, or Grade B, shackles when correctly sized are much stronger than the chain they match. They are two times stronger than the appropriate size G30 or G40 chain, and almost two times the strength, based on our tests, of G43. Even when you move up into high-tensile G70 chain, the Grade B shackles are still 25 percent stronger, if loaded in a straight line.

If you opt for G70 chain, you can still use any of the top-rated American shackles we tested with some confi-

Switching to small-diameter, high-tensile chain (G70 or greater) leads to a hunt for small shackle pins to fit the chain's smaller-diameter openings without weakening the rode. A small-diameter, high-tensile pin joins two U-shaped parts in a hammerlink (at right). Some sailors use omega links (far right) like these 6-millimeter Excel omega links from Van Beest (pictured with G80 chain). The yellow omega connector shows an assembly with a very short clevis pin (centering load). The identical, grey omegas were both Armorgalv-coated; the one on the left was tested to failure. The bow opened slightly, allowing the pin to be released and sheared.

dence. The CMP yellow-pin Grade A shackle we tested could comfortably be used with G30, G40, and G43 chain and would still exceed G70 strength by 15 percent.

We have not changed our views on shackle lifespan since 1998. Shackles should be considered a consumable product and should be regularly examined for corrosion at the pin or any deformation. Owners should carry spare anchor shackles and be prepared to change them regularly. They are not expensive, but they are essential items.

It makes no sense saving a few dollars by buying an unbranded or unrated shackle. Likewise, we wouldn't buy a Grade A shackle when a stronger, Grade B shackle is available for a few dollars more. (Be aware that these higher Grade B working load limits are often achieved by simply reducing the safety factors, so seek out the published safety factor, or UTS.) Any Grade B shackle of the maximum size to fit both chain and anchor would be more than adequate for an imperial G30 or G43 chain. Be sure to buy the maximum size possible, even if the shackle needs a bit of help to fit the anchor shank.

Metric poses a problem. To fit an 8-millimeter metric G30 or G40 chain, it is likely that a 5/16-inch shackle (with a pin size of 3/8-inch, or 10 millimeters) would be required, but this shackle (working load limit of 1.25 tons) might not fit a 45-pound anchor, which would require using two shackles. Peerless has the widest range of shackle sizes, so we would lean toward its supply in favor of Crosby. Campbell also has a more limited size range. Neither Crosby nor Campbell offer shackles for the chain and anchor sizes found on smaller boats.

If you are opting for G70 in an imperial size (using 5/16-inch chain as the example), a 3/8-inch shackle (7/16-inch pin) with a working load limit of 2 tons (12-ton minimum breaking strength) will fit the chain link. The shackle will be stronger than the chain, and would normally fit a compatibly sized anchor. Any imperial-sized galvanized Acco G70 chain will have a Peer-Lift shackle to match it.

Finding a mate for metric G70 is harder. A G70 8-millimeter chain, with its 10-millimeter link aperture (as measured in samples from Peerless or Maggi), should accept a 5/16-inch shackle with its 3/8-inch (10-millimeter pin). Try it first. One problem with G70 is that the chain's actual break strength and the shackle's minimum breaking strength are almost identical, thus erasing the margin of safety that shackles offer in the other combination.

A worse alternative is to use a G80, 8-millimeter Omega link, which in a galvanized form will have a breaking strength of 14,000 pounds (allowing for a 20-percent degradation in strength caused by the galvanizing process). It might be possible to use an Armorgalv-coated link; the Armorgalv process is not as harmful as hot-dip galvanizing. In this case, the breaking strength would be 15,750 pounds (allowing for a conservative 10 percent degradation). This puts a shackle at nearly equal strength to the chain. A final option, which we have not tried, is to use a G100 Omega link treated with Armorgalv. Even when you account for loss of strength caused by the Armorgalv process, it would still have a 20,000-pound breaking strength.

Given that downsizing is the aim of choosing a G70 chain, the best option would be to look for imperial-sized links, as this allows more option in terms of anchor shackles.

One final alternative, is to have larger links welded to the chain at the anchor end (or both, so the rode can be reversed). Some chain companies will do this for you when you order a large quantity of chain. The trouble here is that inevitably, the chain will corrode in certain areas (usually near the ends) and, if you decide to cut away that corroded portion, you'll lose your big end link. (Having a local welder re-attach the bigger link means it will not be galvanized and you would need to have supreme confidence in the welder.)

Until some sensible and easy means is developed to allow an anchor to be attached to a G70 metric chain, it likely will remain only peripheral equipment. We will be exploring some other alternative anchor-chain links in a future report.

CONTACTS

CAMPBELL,
www.campbellchainandfittings.com

CANADA METALS PACIFIC,
www.titanmarineproducts.com

CROSBY,
www.thecrosbygroup.com

MAGGI, www.maggigroup.com

PEERLESS/ACCO,
www.peerlesschain.com

SPENCER INDUSTRIES,
www.spencerindinc.com

VAN BEEST,
www.vanbeest.com

Some offshore racing details for light-air sailing, like two headsails and a powerful main, can be applied to cruising boats, too.

Breaking Down 'Performance'

A look at what performance means and its allies and enemies.

When it comes to sailboats, "performance" is a relative term, especially when it comes to a crew's concept of how the boat will be used. Racing sailors, cruisers, and daysailors each have very different perspectives on performance. For example, those facing a light-air, around-the-buoys race measure performance in terms of how well their speed through the water holds up against the decrease in true-wind speed. Cruisers, on the other hand, especially those crossing oceans, often define it as a measure of versatility under sail, not just how a boat copes with near calms or gales, but how it performs in everything in between.

Ancillary factors such as directional stability, vessel motion, and heeling angle affect the outcome and get lumped into the catch-all label of performance. When scooting down the face of large waves under reduced canvas, steering characteristics and the ability of an autopilot or windvane steering system become part of the performance equation. In fact, "Iron Mike's" steering ability often becomes the limiting variable that tells the cruising crew when it's time to dial back on sail area and slow things down. So the bottom line is that "performance" carries different connotations, depending on the perspective of the crew and limitations of the sailboat and its equipment.

This special report on sailboat performance is the final installation in our boat design series, which launched with a look at sailboat structure in the February 2015 issue; the second report, which focused on sailboat stability, ran in the June 2015 issue.

PERFORMANCE FACTORS

In its most classic context, performance relates to the speed a sailboat can attain on various points of sail, under specific wind and sea conditions. Calculations like the sail area-to-displacement ratio, prismatic coefficient, beam to length ratio, and ballast ratio help define the physical features of a sailboat and therefore provide a baseline for comparing one sailboat with another.

Inshore sailors seeking to get around a windward/leeward or triangular racecourse are confronted with several key realities of naval architecture. On one hand, they are interested in how well a vessel can sail close-hauled, maintaining speed and minimizing leeway. Delivering such performance through a wide wind range and variety of sea states is another boat-design challenge. But going to weather is just half of the equation, and the hull shape favored by off-the-wind sailing is quite different than what makes a boat go to weather.

The upwind aspect of performance deserves a closer look, and for centuries, naval architects have been exploring ways to maximize both the ability of sailboats to sail close-hauled and their ability to resist heeling during the process.

Deep draft, a fine entry, and moderate beam have long been recognized as beneficial traits in weatherly vessels. And higher ballast ratios can be like money in the bank when it comes to preventing and recovering from a deep knockdown—perching crew on the windward

Photos by Ralph Naranjo

A Closer Look at the Rationale Behind the Ratios

Sailboat performance varies based on the eye of the beholder. Racers want light-air alacrity and a willingness to plane while cruisers want directional stability and reasonable speed with moderate sail area. A boat's design dimensions and a few simple ratios give some hints about these attributes.

Most performance-oriented boat designs focus on around-the-buoy racing; these assume that there will be a large crew to keep sail area and trim optimized and to provide movable ballast and that the boat must cope with windward and leeward legs of a race course. Offshore, point-to-point race boat designs are greatly influenced by racing's handicapping rules. In either case, these rules penalize performance, and design factors like ultra-wide beam—intended to leverage crew weight for righting moment—are of little value to shorthanded cruisers. Make sure that the boat you're looking for is fast in the context under which it will be sailed.

The sail area-to-displacement ratio (SA/D) compares energy and resistance—much like a horsepower-to-weight comparison in an automobile. As the SA/D ratio grows higher, so does the vessel's potential speed under sail. However, too much sail area and too little righting moment means a very tender boat. Too little sail area and too much displacement means you can brag about carrying full sail in 20 knots, but your boat will move like a sea buoy in 7 or 8 knots of breeze.

GAUGING PERFORMANCE BY RATIOS

BOAT	WESTSAIL 32	CATALINA 350	JEANNEAU 35	BENETEAU FIRST 36.7	FARR 400
LOA	32′	35′ 5″	35′	36′	38′ 8.5″
LWL	27′ 6″	30′ 3″	31′ 11″	30′ 4″	36′ 5″
BEAM	11′	13′	11′ 6″	11′ 6″	11′ 3″
DRAFT	5′	6′ 6″	6′	5′ 11″	2′ 11″/ 9′ 6″
DISPLACEMENT	19,500 lbs.	14,993 lbs.	11,464 lbs.	11,552 lbs.	9,105 lbs.
BALLAST	7,000 lbs.	5,835 lbs.	3,263 lbs.	4,034 lbs.	5,432 lbs.
SAIL AREA	663 ft.^{2}	595 ft.^{2}	635 ft.^{2}	666 ft.^{2}	1,098 ft.^{2}
ENGINE	37 hp. diesel	35 hp. diesel	27 hp. diesel	29 hp. diesel	27 hp. diesel
WATER	80 gal.	88 gal.	82 gal.	79 gal.	20 gal.
FUEL	70 gal.	39 gal.	34 gal.	20 gal.	18 gal.
SA/D	14.69	15.71	20.1	20.9	40.42
D/L	418.6	241.8	157.7	185.4	84.8
B/D	35.9	38.91	28.46	34.89	59.65

Ordered by sail-area-displacement (SA/D), this table illustrates a progression from a heavy-displacement cruiser (Westsail 32) to a fast and light racer (Farr 400). Note how the designers altered ballast, sail area, and displacement to reach their goals.

The ballast-to-displacement ratio (B/D) of a boat tells you how much secondary righting moment to expect from the keel. The smaller and lighter the vessel, the more important it is for this number to be higher for stability as well as for performance reasons. Bulbs and other keel-tip shapes lower the vessel's center of gravity (CG) and can lessen the need for a 40-percent B/D ratio. A deeper draft can also lower the CG and can improve on-the-wind performance.

A boat's displacement-to-length ratio (D/L) has a lot to do with the resistance of a hull shape moving through the water, and since skin drag is the big enemy at lower speeds, the D/L ratio tells us a lot about a boat's light-air performance. By increasing the boat length and keeping the displacement the same, decreasing displacement, or doing both, the D/L ratio decreases, and the boat will go faster in light air. Wave-making kicks in as the major resistance at higher speeds, and the implications of the D/L ratio lessen.

In a nutshell, when it comes to performance under sail, light displacement is fast; deep-keel boats point higher and sail more efficiently to weather; full, flat sections aft cause a boat to plane sooner; and more sail area delivers more power. When it comes to delivering the goods in an open-ocean context, seakeeping ability is an important factor in performance as is the amount of punishment the boat and crew can endure.

rail can also minimize heel.

More esoteric solutions include torpedo-like ballast bulbs at the tip of the keel, canting keels, and water ballast. The complexity and vulnerability of the latter options relegate them to boats at the most extreme end of the performance spectrum. However, all of these increase righting moment, work to reduce heel, and allow more sail area to be carried.

PERFORMANCE ENEMIES

Windage, wave making, and skin drag are performance enemies. The latter is linked to excess submerged surface area and a frictional relationship with seawater that adds drag and slows down a boat. Lighter-displacement hulls with deep keels and modest sail area can also prove to be quite nimble and weatherly, especially with new rig technology that lowers weight aloft and provides inboard sheeting and mast bending, which enhance sail shaping. But these lightweights really scoot off the wind because there's less mass to accelerate, and their flatter sections and beam-carried-aft hulls are quite willing to plane.

WINDWARD PERFORMANCE

It's clear that a modern sailboat's ability

Gauging a cruising boat's performance includes considering its ease of sail handling, its ability to be steered by autopilot or a wind vane, and its seakindly motion.

to sail to windward is a combination of hull shape, underwater foil development, and rig and sail technology. Sloop rigs hold an advantage due to their high-aspect ratio, which exposes minimal sail area to turbulent flow. But what complicates the performance picture—and is a big challenge to crew and boat designers/naval architects—is the very different set of design characteristics favored in off-the-wind sailing.

For example, a wide beam carried aft and a flat bottom tend to enhance sail-carrying ability and improve a sailboat's tendency to plane. Sometimes referred to as "sleds," downwind-specialized designs often have more difficulty when it comes time to sail upwind. The lift-developing underbody—which is a big plus on a reach—can force the bow down during a beat to windward, causing the vessel to head more off the wind and requiring added rudder deflection to maintain the desired angle of attack. These characteristics obviously have less negative influence in off-the-wind races; but when headed around the buoys, where upwind performance plays a crucial role, such designs lose their edge. This Achilles heel is even seen in older, beamy, around-the-world race boats, which favor off-the-wind sailing. Today's races have more port calls, requiring a solo sailor to beat toward finish lines in variable weather conditions.

RACING RULES

For well over 100 years, yacht designers and naval architects have been dealing with racing handicap rules meant to level the playing field and allow different sized and shaped sailboats to fairly compete, even though they may finish an ocean race several days apart. Absent from auto racing, this concept is like mingling minivans and Ferraris at Le Mans—allowing a well-driven Honda Odyssey a chance to grab the silver.

Over the years, rating rules have come and gone. Some penalized length, sail area, beam, or ballast. A few have even tried to take crew competency and weather conditions into consideration. One of the biggest problems in developing fairness in a rating system is that once the parameters are known, designers are able to work their way around each obstacle, utilizing less-penalized characteristics to enhance performance. In some ways, it's like a tax lawyer exploiting the loopholes.

One of the most egregious examples of rating-rule exploitation was seen in the tragic *WingNuts* capsize that occurred in the 2011 Chicago-Mackinac Race. (See *PS* April 2012 issue.) The incident underscores the way dangerous design attributes can be masked by a rating rule that fails to effectively penalize excessive beam; in the *WingNuts* case, this meant a boat with insufficient stability was allowed to participate in what was essentially an offshore race. The overnight, 289-nautical-mile Chicago-Mac race is held on Lake Michigan, a body of water that's known for bad squalls and rough seas.

The hull of *WingNuts*, a Kiwi 35, flared out dramatically where it meets the deck. Its wide deck and extreme beam at the shear line did afford a hiking platform, but much of the boat's initial righting moment relied on crew weight perched on the windward rail. The same weight became a negative influence when heeling toward capsize in a strong breeze. The rating rule's stability index used for the event did not properly penalize the huge difference between the Kiwi 35's waterline beam and the deck-level beam, which led to a stability shortfall instigated by the excessively flared topsides. The rule levied a maximum penalty of 5 degrees against excess beam, regardless of how extreme the design distortion happened to be. This exaggerated deck-level beam distortion caused the vessel's actual Limit of Positive Stability (LPS) to drop below 80 degrees, while its rated stability index was calculated to be 106 degrees, allowing the boat to participate in the race. (For more on boat stability, see *PS* June 2015.)

In flat water and light-to-moderate winds, the Kiwi 35 design was effective and delivered a high level of performance. But as the wind increased and the seas built, the vessel began to heel excessively in the gust, submerging the leeward wing, which had little reserve buoyancy. Even with reduced sail, the distorted beam-to-length ratio negatively impacted the boat's seaworthiness.

When it comes to sailboat design, performance must be viewed in the context of overall seaworthiness, and considered in accordance with the range of conditions the vessel is likely to encounter. This is equally important for cruising boats and racing boats, and it's why most designers pay special heed to how

Modern, light-displacement race boats sport higher SA/D ratios, favor small jib/big main sailplans, and reach with asymmetric spinnakers.

Skiff sailors plane early with light, flat, wide hulls, and innovative ways to deck-sock set a big asymmetrical spinnaker.

and where a vessel will be sailed when defining its performance/seaworthiness attributes. (Check out *PS* February 2009 online, which looks at modern boat design, and whether quests for speed and interior comfort are trumping smart design.)

The popularity of the cruising/racing sailboat has waxed and waned over the years, and in some ways, it's like the automotive industry challenge of creating sportscar-handling in an SUV—easier to achieve in ad copy than on the track. Today, there is less point-to-point club racing, and around-the-buoys weekend events are being dominated by popular one-design classes and racing sailboats with anything but a live-aboard interior.

The bottom line is that there's less emphasis on performance in what's being labeled a "cruising sailboat." This is especially true when it comes to the on-the-wind performance that's missing in many mainstream production cruising sailboats. As a good friend once said, "Put up enough sail area, and you can get a floating dock to sail off-the-wind, but the real art in cruising boat design is to create good all-around sailing characteristics on all points of sail."

DELVING INTO DETAILS

In our recent report on boat stability (see *PS* June 2015), we gave a thumbs-down for the combo of high-volume hull shapes with wide beams, shoal draft, and low ballast/displacement ratios. When such sailboats are used as offshore cruisers, they afford too little secondary righting moment and deliver an LPS that's too low (less than 110 degrees). Such designs take another hit when it comes to upwind performance. Their full, round hull shapes actually hide the short, stubby keel as the vessel heels. This all but eliminates the lateral plane effect and the lift associated with the keel foil. Leeway increases, and progress to windward is significantly diminished.

Those cruising shoal waters—and willing to do some motor sailing to augment poor windward performance—may find the accommodation volume increase afforded by these beamy, shoal-draft designs a fair trade for on-the-wind sailing performance. But when it comes to offshore passagemaking and the ability to claw off a lee shore under sail, there's no substitute for at least moderate draft and a meaningful ballast/displacement ratio (30 percent coastal and greater than 35 percent for offshore).

Cruising boat performance under sail is hinged on several inter-related factors. A few are linked to the same design criteria found in racing sailboats and mentioned earlier, but others are contingent on issues that are unique to cruising. Take for example the widespread use of an autopilot or self-steering vane—a cruising constraint with significant performance implication. Despite the fact that autopilot IQ is improving as more complex algorithms are used in the hardware, this artificial intelligence is not linked to the winches and sail trim to cope with oscillations in wind speed and direction. Consequently, an autopilot or vane compensates for changes in pressure on the sail plan with rudder deflection rather than trim changes, and some very specific boat dynamics come into play.

For example, directional stability, the tendency of a hull to maintain a course and not yaw excessively, can be very important. As a vessel's speed and seaway motion increase, sailboats with less directional stability require excessive rudder response to stay on course. In a performance context, this becomes a limiting variable. Even with new autopilots, packed with better logic circuits, and able to learn the steering behavior of a vessel, there's a point where yaw outstrips steering control.

In the past, better directional stability has been linked to a longer run of keel and split rigs that allow sail area to be parceled out and balanced more efficiently. Today, larger, high-aspect ratio, semi-balanced rudders with stocks rotating on roller bearings, require less autopilot or steering vane torque, and therefore deliver more course correcting force more quickly. Even so, these contraptions are a non-seeing, non-sail trimming alternative to a helmsperson, and directional stability still remains a limiting variable when it comes to cruising-boat performance. The bottom line

In windy regions, small, reefable, flat-cut jibs simplify tacking and help make windward progress in a stiff breeze.

A Solent sail set on an inner forestay is another approach to making windward progress in a building breeze.

is that "squirrelly" is not a good description of steering attributes aboard a cruising boat.

Another big player in cruising-boat performance is sail area—or more specifically, the ability to dial in the right amount of sail area as quickly and easily as possible (which can be limited with a short-handed crew). Ironically, a racing sailboat's sail area is often constrained by handicap formulas, while cruising boats face no such restrictions. And yet there's a universal assumption that cruising boats should have short masts, and racers get the really tall ones. Reliable diesel auxiliaries have entrenched this stereotype, as many cruisers are quick to reach for the ignition key rather than light-air headsails.

A big rig doesn't mean you have to keep full sail set in 15-plus-knot conditions. Reefing early keeps the boat sailing flatter and steering easier, and very little speed is lost. But what lies in reserve, in the form of reefed sail area is the canvas to make 5 to 8 knots of true wind a viable sailing breeze. This is why many traditional sailboats from the no-iron-genoa era had tall rigs, lengthy bowsprits, and long booms, in order to supersize their sail area when the breeze went light.

Modern furling gear is like a photographer's favorite zoom lens. It delivers the ability to cope with varying conditions and makes sail changes easier than ever. Purists argue that roller-reefed sails must be cut flatter and lack some of the drive inherent in conventionally cut sails. While this is true, it's only part of the equation; you can make up for much of the shape shortfall by always adding or reducing sail area and maximizing drive, thanks to how easy it is to let out or take in sail.

Around-the-world singlehanders have taught cruisers a good lesson. They sail with very tall rigs, and more often than not, their mainsail is reefed rather than fully hoisted. This ensures that there's some extra sail area ready to coax them through light-air stretches. In addition, most pack an arsenal of roller-furled headsails to cope with various sailing angles and wind/sea conditions. Cruising sailors don't need copies of boats sailed by these iron men and women of the roaring forties, but we need to recognize that a big rig with furling/reefing versatility can significantly increase efficiency under sail in lighter winds.

Lastly, in our cruiser's performance perspective, we need to think of payload and the influence that extra water, fuel, provisions, anchors, and gear have on our boat's ability to slip through the water. The really diabolical effect all these cruising essentials have on performance plays out in elevated skin drag, wavemaking, and decreases in freeboard. Teamed up, these performance parasites can add days to an ocean crossing.

Multihull sailors are most vulnerable, because their boat's lean, long hulls submerge more per pound as payload soars. The resulting drag increase is significant, and as the bridgedeck grows closer to the loaded waterline, the number and severity of wave slams increase, further impacting performance and comfort aboard. The answer here is to heed the designer's calculation of maximum payload, and do a serious audit of your cruising essentials. Make sure that the payload statistic is based upon fuel and water tanks being at topped off capacity.

THE POWER PLAY

Many cruisers reconcile light-air performance with gallon-per-hour fuel statistics, and as long as the machinery and tankage are up to the task, it's a perfectly viable approach—especially if you don't mind the combustion rumble and the fumes linked to mechanical propulsion.

Little things like picking an efficient cruising speed can be a big deal, especially when it comes to efficiently motoring long distances. Optimizing performance involves matching the sweet spot defined by the hull dimensions and wave-making characteristics of a given hull shape with the prop and torque curve of the engine. The best compromise among fuel efficiency, speed, drag, and wavemaking is usually found around 75 percent of hull speed. A prop's diameter and pitch should be set to deliver the manufacturer-specified, full-throttle RPM with a cruising payload on board. Setting pitch to increase speed at lower RPM can cause overheating, incomplete combustion, and serious engine damage.

Inshore sailors may define performance under power as maximum speed rather that maximum miles per gallon. They have many more opportunities to fill the tank and may want to shorten the time it takes to get from point to point rather than stretch the fuel for the maximum number of miles. To answer the performance quest of fast-under-power sailors, prop pitch and diameter should be set to deliver more thrust at the higher end of the RPM range. Naturally, fuel consumption will increase dramatically and wave making also will increase as the boat attempts to outwit the constraints of a displacement hull shape.

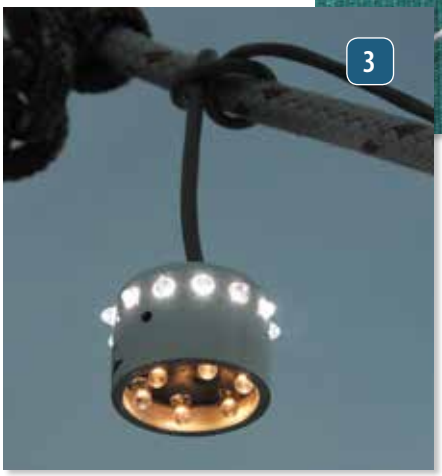
The concept of performance is a bit of a moving target that's based on the vantage point of each sailor. Racers have a very defined set of goals while a cruiser's requirements are usually more multifaceted. But when it comes to designing a fast sailboat, the variables involved have been well researched, and designers and their computers have been effectively blending the attributes.

The arcane part of the science lies in the balancing act linked to optimizing a sailboat for a specific rating rule. Add to the equation the need for an appropriate level of seaworthiness, and it's clear that yacht design is all about juggling important variables, and performance is only one of several key attributes.

Onboard Security

DIY alarm system deters would-be boat burglars.

By Patrick Childress



1. *Cruiser Patrick Childress designed a DIY boat alarm system using a bugle horn and round truck horn.* ***2.*** *The horns are wired to booby-trapped mousetraps (propped open with pencil for photo purposes).* ***3.*** *Night-sensing LED lights hung in the cockpit and on the foredeck also can help deter would-be thieves.*

Photos by Patrick Childress

Some ports and anchorages are safer than others, but it never hurts to be cautious when it comes to boat security. When you're away from the boat, blasting a loud stereo down below can give the appearance that someone is onboard and may slow a prospective thief. (Doesn't everyone turn radios and TVs off when they leave?) Trailing a spare dinghy or kayak off the stern is also a good deterrent, as is on-deck illumination.

Modern LED lighting has such a minuscule power draw that cabin lights can be left on for 24 hours a day along with the stereo to keep would-be robbers at bay. A good solar panel will have no problem replacing the amperage. Arch-mounted LED anchor lights or an LED spreader light is well worth the expense in amperage to repel thieves. There are even darkness-sensing, combination anchor/cockpit lights—such as the one from Bebi Electronics (*www.bebi-electronics.com*)—that can be hung from the foredeck or cockpit and will come on with darkness and turn off with the sun.

To take your security measures a step further, you can install an "alarm system." The problem with most store-bought, battery-operated, motion-sensing or magnetic alarms is that they are not much louder than a chirping cricket. They are not very scary to a thief who is determined to break into a boat, so we came up with our own, *much* louder alarm system.

When we had to leave our boat unoccupied on a mooring in a foreign port (Majuro, Marshall Islands) for an extended time, what saved our boat from intruders was our final line of defense, which we named the IMD, or Improvised Mousetrap Device.

In the event a thief breaches our boat's companionway hatch and lifts up the top hatch board, he would be pulling on a trip line made of thin sail thread that is screwed to the bottom of the board. At the other end of the thread is a mousetrap. Once the trip line's 4 inches of slack are pulled taught, the mousetrap slaps shut. This trip mechanism (the trap) activates two audible alarms: a most piercing, 122-decibel siren camouflaged in the cockpit and a truck horn mounted in the cabin in an open port light facing into the cockpit. These noise blasters are hidden from view by a plastic bag and coils of lines.

We like the redundancy of the two horns. In case of malfunction or the thief discovering the siren in the cockpit, the interior horn will still blast. Plus, the mega-decibel blast of high- and low-range frequencies covers a full-audio effect across the mooring field and the nearby city waterfront.

To construct the alarm system, we soldered the horn's positive wire to the movable jaw of the trap and screwed its corresponding wire to the wood base, so a circuit was complete when the trap was sprung. The loud horns were hard wired and fused into our 640-amp-hour battery bank. Installing these traps required calculating for the proper wire size so the length of wire needed would feed plenty of high-powered amperage to the horns.

We also installed another mousetrap circuit under the forward saloon hatch, which we left propped open for ventilation; the dinghy, stowed upside down on deck, served as a cover. We ran trip lines to the handles inside the dinghy, and a third trip line ran from this same mousetrap to the forepeak, where it was tied to a cushion that was tightly wedged below the hatch.

On our 34th day away from the boat, at 1:30 in the morning, the anchorage and the Majuro waterfront, were awakened by screeching sirens and horns blasting from our boat. The loud alarms were soon silenced, and the traps were reset by a cruising friend who knew our setup, but the IMD saved our boat from damage and theft.

If you're interested in setting up your own IMD, trip lines can be set across the sidedeck or tied to fuel jugs. There are incalculable ways to use an IMD to protect your boat and equipment and to scare the coconuts out of local thieves—and all their relatives on shore.

Tap Water that's Better than Bottled

Universal filters provide the most practical solution for final onboard water filtration.

If you've followed the first two installments in this three-part series on ensuring safe, fresh-tasting drinking water onboard, you've cleaned your freshwater tank, pre-filtered all water going into the tank, screened the vent, and disinfected the contents. Now that the water has sat in the tank, it's time for one more filtration process; this time, focusing on improving taste and eliminating micro-organisms.

Our goals are modest: remove chlorine residuals, cysts, and most bacteria with inexpensive and simple 0.5-micron, carbon-block filters. Pathogenic viruses are a tiny risk in most developed areas, and chlorine treatment should eliminate them.

The sailor headed outside the U.S. and to areas where the quality of tap water is less certain will set higher goals. He will consider adding a filter certified by the National Sanitation Foundation (NSF) to remove cysts, bacteria, and even viruses. Certified filters cost more, but bring peace of mind.

All of the filters we discuss here can be used to filter water from a reverse osmosis (RO) watermaker. (See *PS* February 2013 online for our most recent watermaker test.) Why filter watermaker water? Although the reverse-osmosis process eliminates most microorganisms, the chance of internal leakage prevents them from being NSF rated as true microbial barriers without additional treatment.

FILTER MEDIA

In the previous article on pre-filtration of tap water (see *PS* June 2015 online), we discussed filter media—pleated elements, granulated activated carbon (GAC), and GAC with kinetic degradation fluxion (KDF). (See the online version of this article for links to that discussion.) Assuming the tank has been well maintained, the water is ready for final filtration. Granulated carbon filtration is not appropriate filtration at the tap; the canisters shed fine particles, and in the absence of consistent chlorination—something you have at home but not on the boat—they grow bacteria. A fine-pleated element is no help for final filtration either; we've already removed everything that it filters out—sediment and clumps.

Using a separate tap for potable water simplifies the installation and prolongs the life of the filter.

CARBON BLOCK

Activated carbon is powdered, then combined with additional filtration aids, and with the addition of a binding agent, it is compressed into a solid tube. The result is very fine filtration, ranging from 5 microns to 0.5 microns. A pressurized water system is generally required, but 0.5-micron filters will positively block protozoa and cysts, including cryptosporidium parasites, and provide substantial reductions in bacteria and viruses.

CARBON BLOCK PLUS MEMBRANE

Pentek revolutionized this niche by combining a carbon-block filter with a membrane microbiological barrier located in the core, all within a cartridge that fits inexpensive, standard filter housings. To improve bacteria and virus capture, the company has upgraded from a single knife-edge seal (standard cartridges) to a double O-ring seal. This required a slight modification of the standard housing to a version that Pentek calls "3G." The new housing is backward compatible with older cartridges.

STRUCTURED MATRIX

General Ecology has produced structured matrix filters under the Seagull brand for over 40 years, earning a solid reputation worldwide. Simple and maintenance free, structured matrix filters are closely related to carbon-block filters.

The maker claims structured matrix removes viruses, but it is not NSF certified for this purpose. Its removal of viruses is somewhat dependent on adsorption mechanism, and there is some risk of bleed through after the rated life is exceeded. This is not a problem if the unit is replaced on a regular schedule.

In theory, positive capture of viruses requires incredibly small pores, as small as 0.003 microns absolute, requiring construction similar to a reverse-osmosis unit. However, one filter in this review has a pore size of 0.019 microns, and is certified to NSF-P231, suggesting that adsorption mechanisms are stable

Photo by Frank Lanier

PS VALUE GUIDE WATER FILTERS, 2 x 10-INCH STANDARD HOUSING

PRODUCT	PENTEK CBC-10 ✓	PENTEK MICROGUARD 10MCB	Kx MATRIX 06-250-125-975 NT $	GENERAL ELECTRIC FXULC NT ✓	PENTEK FLOPLUS-10 ★	DOULTON SUPER CARB OBE ✓
CERTIFICATION	None	NSF-53	NSF-53	NSF-53	NSF-53	NSF-53
STANDARD SIZE	2 x 10	2 x 10 3G	2 x 10	2 x 10	2 x 10	2 x 10
ACTUAL CARTRIDGE SIZE	2.5 in. x 9.75 in.	2.88 in. x 10.23 in.	2.5 in. x 9.75 in.	2.5 in. x 9.75 in.	2.88 in. x 9.75 in.	2.88 in. x 9.75 in.
OVERALL DIMENSIONS (H x DIAMETER)	11 3/4 in. x 4 3/8 in.	11 3/4 in. x 4 3/8 in.	11 3/4 in. x 4 3/8 in.	11 3/4 in. x 4 3/8 in.	11 3/4 in. x 4 3/8 in.	11 3/4 in. x 4 3/8 in.
FILTRATION MEDIA	Carbon block	Carbon block + membrane	Carbon block	Carbon spun fiber	Carbon block	Ceramic + carbon block
MICRON RATING	0.5 µ	0.15 µ	0.5 µ	0.5 µ	0.5 µ	0.9 µ
CAPACITY (CHLORINE REMOVAL)	2,400	6,000	6,000	6,000	10,000	10,000
FLOW RATE AT 30 PSI	1.6	1.0	0.8	0.9	2.0	$2.00
PRICE (CARTRIDGE)	$14.10	$74.99	$13.99	$28.98	$15.99	$43.87
PRICE (SYSTEM)	$27.09	$129.95	$26.98	$41.97	$28.98	$56.86
COST TO OPERATE ($/GALLON)	$0.006	$0.125	$0.002	$0.005	$0.002	$0.00

★ Best Choice ✓ Recommended $ Budget Buy * Not tested by *PS*

PS VALUE GUIDE WATER FILTERS, 2 x 5 INCH & PROPRIETARY HOUSINGS

PRODUCT	PENTEK CBC-5 ✓	Kx MATRIX 1-250-125-050* ✓	PENTEK VP-100-QC/V500 ★	GENERAL ECOLOGY SEAGULL IV ✓	GENERAL ECOLOGY NATURE PURE QC-2 ✓
CERTIFICATION	None	None	NSF-P231	None	None
STANDARD SIZE	2 x 5	2 x 5	Proprietary	Proprietary	Proprietary
ACTUAL CARTRIDGE SIZE	2 7/8 in. x 4 7/8 in.	2.5 in. x 4 7/8 in.	22 x 3 x 4	Proprietary	Proprietary
OVERALL DIMENSIONS (H x DIAMETER)	7 in. x 4 3/8 in.	7 in. x 4 3/8 in.	11 3/4 in. x 4 3/8 in.	5 3/8 in. x 5 in.	9 in. x 3 in.
FILTRATION MEDIA	Carbon block	Carbon block	Carbon block + membrane	Carbon block hybrid	Carbon block hybrid
MICRON RATING	0.5 µ	0.6 µ	0.019 µ	0.4 µ	0.4 µ
CAPACITY (CHLORINE REMOVAL)	1,200	1,200	500	1000	800
FLOW RATE at 30 PSI	0.8	0.7	0.5	1	0.8
PRICE (CARTRIDGE)	$9.85	$11.95	$89	$104.00	$110.00
PRICE (SYSTEM)	$22.84	$24.94	$425	$596.00	$285.70
COST TO OPERATE ($/GALLON)	$0.008	$0.010	$0.178	$0.10	$0.14

★ Best Choice ✓ Recommended $ Budget Buy * Not tested by *PS*

and effective for removing virus and that some NSF-53-certified filters, like the Seagull filters, might also help keep out viruses.

PITCHER FILTERS

None of the popular pitcher filters are certified to remove cysts or perform fine filtration. These filters can help with taste, but offer only an illusion of safety. In our opinion, these filters aren't worth the counterspace they will occupy on the boat.

WHAT WE TESTED

We focused our testing on carbon-block filters, since these offered the best combination of affordable price, ease of installation, and effectiveness. We previously tested the more sophisticated Seagull structured matrix filter. (See *PS* October 2013 online.) We also reported on some NSF-certified units we did not physically test; NSF testing is independent and more rigorous than anything we could perform, and we have confidence in the numbers on NSF-certified systems.

HOW WE TESTED

We began our evaluation by installing a carbon-block filter (Pentek CBC-5) on a test boat. Because our mounting space was tight, we chose the smallest standard cartridge size (nominal 2-by-5 inches). Realizing there was sufficient space for a larger size, we substituted a 2-by-10 housing to provide faster water flow. With the NSF-certified products, we measured flow rates and chlorine removal efficiency, to confirm what they reported. We used a combination of lab-

Making Sense of Water Filter Certification

Only a few states require National Sanitation Foundation (NSF) certification for water filters, and the requirement applies only to a small number of original equipment manufactured (OEM) products.

Performance is tested using real-world volumes and real-world water, containing sediment, cysts, bacteria, and viruses (particle substitutes are permitted for some tests). Filter removal and flow rates are measured at the beginning, middle, and at the end of the test.

It is important to understand which NSF rating applies and to what components. An NSF-certified filter might be rated only for structure and leaching (NSF-42); in this case, all other ratings (removal of chlorine, bacteria, viruses, etc.) are based on manufacturer testing. Here are the most common filter standards.

PS VALUE GUIDE NSF FILTERS

ORGANISMS	SIZE RANGE (MM)	EXAMPLE (SIZE IN MM)
CYSTS (NSF-53 FILTERS)	4-14	Cryptosporimium (4-8)
PROKARYOTES		
BACTERIUM: TYPICAL ROD	1.0-0.5 x 1.0-10	Pseudomonas aeruginosa (1.5 x 0.5)
BACTERIUM: TYPICAL SPHERE	1 diameter	Bacillus megaterium (7.6 x 2.4)
EUKARYOTES		
FUNGI: FILAMENTOUS	8-15 x 4-8	Mucor hiemalis (8 diameter)
RED TIDE	5-75	(disolved toxins may be present in red tide)
FUNGI: YEAST CELL		Saccharomyces cerevisiae (29-49.1 µm3)
ALGAE	28-32 x 8-12	Chlamydomonas
VIRUSES (NSF-P231 FILTERS)		
VIRUS	0.015 x 0.3	Poliovirus (0.03 x 0.03)
		Tobacco mosaic (0.0)

NSF-42 AESTHETIC AFFECTS

This standard covers materials of construction, strength, and filtration efficiency. It usually applies only to the filter materials, confirming the filter's structural integrity and that it won't leach lead and certain plasticizers. The standard also covers chlorine reduction and filtration efficiency, but there are multiple tiers of approval; a certified faucet-end filter might remove as little as 25 percent of the chlorine and particles greater than 50 microns, while a carbon-block filter will typically remove more than 99 percent of the chlorine and particles greater than 0.5 microns. To know which applies, check the certified specs. You can search the NSF certification database by manufacturer, part number, or product type at the NSF website: *http://info.nsf.org/Certified/dwtu/*.

PROTOCOL P-231, MICROBIOLOGICAL PURIFIERS

Based on the latest EPA research, this procedure has not been formally accepted by the NSF or the American National Standards Institute (ANSI). The filtration device must reject bacteria and viruses at all stages of a 10.5-day test, using water that mimics U.S. municipal water for six days and domestic sewage (high TOC, high TDS, high turbidity, high pH, low temp) for four-plus days. Reverse-osmosis systems generally fail this test, since the membranes commonly have some minor leaks. Double O-ring seals are standard. While there are systems approved that use combinations of reverse osmosis, ultraviolet sterilization, and chemicals, we have reviewed only cartridge filter systems. In our opinion, any P231-certified device is certainly safe.

NSF-53 HEALTH EFFECTS

This standard requires substantial removal of a wide range of chemical pollutants spelled out in the Environmental Protection Agency's drinking water standard. Additionally, it requires removal of 99.95 percent of cryptosporidium cysts. Relatively few filters are certified to NSF-53.

NSF-55 UV STERILIZERS

Ultraviolet purifiers are certified in two categories: Class A is for water of unknown microbiological content and requires 40 milliwatts per centimeter squared of UV in the 250- to 300-nanometer range, while Class B is intended for water that is microbiologically safe and requires only 16 milliwatts per centimeter squared. The unit must demonstrate efficacy against bacteria and viruses.

oratory equipment and aquarium test strips during our testing; the test strips never conflicted with our lab results.

FIELD OBSERVATIONS

Filters designed to eliminate chlorine taste are rated by the total number of gallons they can remove, based on standard 2 parts per million (ppm) free chlorine. If you can taste chlorine or detect it with a test tape, the filter may be due for a change. However, carbon-block filters are very efficient at removing chlorine; the chlorine reacts with the carbon and organic materials adsorbed onto the filter, slowly burning it away. In fact, low levels of chlorine extend filter life by burning off minor organic contaminants, beyond 1,000 gallons this process increases pore size, reducing filtration efficiency and increasing the microorganism pass-through; do not over-chlorinate.

Carbon block filters do slow the

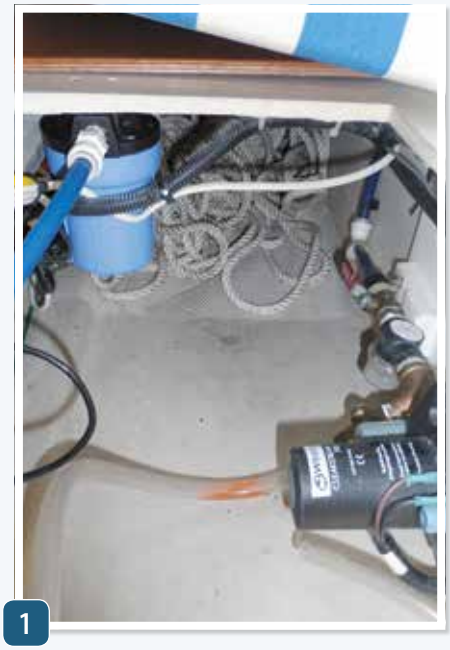
Pay Attention to Installation

No filter will work as it should if you overlook installation details. Some things to keep in mind:

1. We prefer opaque filter housings (top left). This installation uses quick-connect lines designated for potable water.

2. The 3G housing (left) accommodates the more reliable double O-ring seal used by the MicroGuard MG-10MCB versus the single knife seals found in standard cartridges (right).

3. The interior of this Pentek CBC-10 carbon block filter reveals its very fine pores.



1

2

3

Photos by Drew Frye

water flow significantly, but never below usable rates. With the 0.5-micron, 2-by-5 block (Pentek CBC-5, the finest tested), the rate was like a refrigerator-door water dispenser—noticeably slow when filling pots—but after upgrading to the higher volume 2-by-10 FloPlus 10, we did not notice any reduction in flow.

After installing each cartridge, we used volunteers for blind tasting. We drew a sample from the tap, a sample of bottled water, and a sample of local tap water (unfiltered). We used Deer Park as the bottled water standard after determining by analysis that the mineral content was very similar to local tap water.

INSTALLATION

While it can be desirable to filter the whole boat's tank water, many people filter only the tap used for drinking. If you choose to filter only the cold water in a single tap, there is some risk of contamination with unfiltered hot water. Most of the units we reviewed are relatively low flow (1.5 to 2 gallons per minute) and are suitable only for a single tap. However, the Doulton Rio-2000 (9.8 gallons per minute) is suitable for whole-boat filtration. Keep in mind, that as long as the tank is chlorinated, risks in the shower and at other taps are trivial. Do use the hot water regularly, even if not heated, to pull fresh chlorinated water through all of the pipes to reduce biological growth in the lines.

Foot pumps might affect performance. We tested only one filter—the Pentek FloPlus-10—using a Whale Gusher foot pump, and found that it took about 30 seconds of slow but steady pumping to fill a glass. A cruiser with a Seagull IV X-1F reported a similar effort. These filters work much better on pressure water systems.

HOUSINGS

We focused our test on universal cartridge housings. We like the flexibility, worldwide availability, and economy. We see no upside in proprietary systems, which are vulnerable to design changes and pricing vagaries, and offer few options for refills. Specifically, we like the Pentek 3G Slimline 10-inch housing for on-board applications; it takes the greatest variety of elements and is very economical. We see no benefit to clear housings, especially for dockside use; they are more vulnerable to damage from the sun's ultraviolet light and encourage algae growth.

We like housings with half-inch NPT fittings. They adapt to a variety of plumbing types. We don't like pressure-relief fittings or pressure gauges; they add failure points and complicate installation. We have used these housings in industrial settings for many years and have confidence in their durability. Cost is $11 to $45, depending on features.

CARTRIDGE FILTERS

Except where otherwise noted, all products were tested in Pentek housings. The 2-by-5 housing was a Pentek half-inch FPT Slimline housing (Model 35-125F, part number 158203, $13). The 2-by-10 housing was a Pentek half-inch FPT 3G (Model 35-125F, part number 158648, $12). Both are NSF-42 certified and rated for pressures up to 120 pounds per square-inch.

KX MATRIKX

Rated to 0.6 microns, the KX Matrikx (1-250-125-050) filter is a good example of a 2-by-5, carbon-block filter. The manufacturer is well-respected in the field of filtration, and the $12 filter prices are reasonable.

Bottom line: Just a notch below our favorites in this category from Pentek, the KX Matrikx filter is Recommended.

PENTEK CBC-5

Though it's not rated to NSF-53 standard, Pentek's CBC-5, a 0.5-micron, carbon-block cartridge filter, should stop cysts and a good portion of bacte-

Pentek Microguard MG-10MCB

ria. It did slow the water flow appreciably, down to 0.7 gallons per minute at 35 pounds per square inch, about the same as a fridge tap. Increasing the housing to the 2-by-10 version will give you all the flow you need for a galley tap. For this reason, and because 2-by-10 cartridges are available more places and in more types, we recommend a 10-inch housing, if you have the space. It had all the life we need, excellent smell and taste improvement. It is priced at about $10.

Bottom line: This is all the typical U.S. coastal sailor needs while he is filling with safe water. Recommended for smaller boats.

Pentek CBC-10

PENTEK CBC-10

The Pentek CBC-10 carbon-block cartridge filter is the big brother of the CBC-5 we installed on the test boat. It delivers twice the flow (1.5 gallons per minute at 35 pounds per square inch). Several cruisers we know prefer this filter. Prices run about $14.

Bottom line: Recommended. A good choice for bigger boats that don't need an NSF-53 filter.

NSF-53 CERTIFIED FILTERS

Independently verified to remove microbial cysts from water, the NSF-53 certified filters will also remove nearly all bacteria and viruses, but they are not certified for this purpose. Except as otherwise noted, all tested NSF-53 filters were in Pentek G3 housings, as described above.

DOULTON STERISYL SUPER CARB

This filter by Doulton Ceramic Filter Systems was the only one we found that was designed to be cleaned and reused. It is very popular in England. According to the full-time cruisers we spoke with, the Doulton Sterisyl filters can last up to two years with occasional cleaning. Prices run about $44.

Bottom line: Recommended. A good pick for the year-round sailor; carbon-block filters (replaced annually) makes more sense for seasonal sailors.

KX MATRIKX

The inexpensive KX Matrikx 06-250-125-975 provides all the protection a U.S. sailor will need. The flow rate is a bit slower than other filters (0.8 gpm), but it's adequate for a point-of-use device. Price is about $14.

Bottom line: This 2 x 10 filter is our Budget Buy among filters that meet the NSF-53 standard.

PENTEK FLOPLUS-10

The FloPlus-10 is our favorite all-around choice among NSF-53 filters. It costs more than others, but we liked the combination of high flow-rate, acceptable clogging resistance, a fair price, and an NSF-53 rating. Filters cost around $16 each.

Bottom line: This is our Best Choice in the NSF-53 category, and our Best Choice overall for U.S. sailors.

PENTEK MICROGUARD

Pentek stepped up sealing efficiency with the MicroGuard MG-10MCB by upgrading to a double O-ring seal versus the single, knife seals found in standard cartridges. You'll need a 3G housing for these filters, but these cost only a few dollars more, and you can still use standard filters in the 3G housing.

This filter boosts the already excellent carbon-block filtration with a membrane; internal testing shows 99.9999 percent reduction in bacteria and viruses; however, it does not carry NSF-P231 certification. What is revolutionary is that they have done this with a standard, widely available filter housing. It accepts less expensive carbon-block cartridges ($14) when the protection of the MicroGuard element ($72) is not needed.

Bottom line: The cruiser who treats and maintains his tank won't need the MicroGuard filter. However, it is a low-cost option for the off-the-beaten path cruiser who doesn't want to pay for a P231-certified filter. It's our Budget Buy for bacteria and virus protection.

KX Matrikx 1-250-125-050

GENERAL ELECTRIC

The FXULC NT filter by General Electric is NSF certified and available though chain home improvement centers, but we can't see it performing much better than the less expensive Pentek FloPlus-10.

Bottom line: We Recommend this filter, based on its NSF-53 rating and easy availability, but we'd opt for the FloPlus-10 instead, if both were available.

MICROBIAL BARRIER FILTERS

Microbial barrier filters are NSF-P231 certified, meaning they meet the specifications for making microbiologically contaminated water safe to drink without the use of disinfection chemicals. However, if the water source is not trustworthy, we still recommend prior disinfection as a safeguard against leaks in the seals and downstream infection. For most sailors, this level of filtration is overkill; the primary market for this category is homes on well water with septic systems that they don't trust.

PENTEK VP-100-QC/V-500

Pentek's VP-100-QC/V-500 cartridge filter is an under-the-sink filter clearly marketed to the homeowner who needs a slick look and no-drip cartridge changes. Connections are via 3/8-inch quick-connect, which we do not like because they don't match up with most boat plumbing; we prefer standard pipe threads, which can be adapted to suit. Also, this filter is not cheap. Prices start at around $89 for the element and $459 for the system.

Bottom line: The only difference between this, the Seagull, and the MicroGuard may be the paperwork.

PREVIOUSLY TESTED

We previously tested several filters and have recommended these products in the past. They live up to their claims, but to get the most bang for the buck, one of the other test products may be a better choice.

GENERAL ECOLOGY SEAGULL IV

General Ecology's Seagull IV, a well-known and well-proven filter—along with its cousins the First Need back-country purifiers—has been used worldwide for decades. The sturdy, stainless-steel housing has proven reliable, with only occasional reports of leakage after long years of service.

Our chief concern is that this unit is not NSF certified for filtration efficiency or cyst removal. This is offset by a long and respected service history, and the many organizations that have tested and accepted the family of devices. Our other gripe is the price. At $104 for the element and $596 for the system, we should at least get an NSF certification.

Bottom line: Because of robust construction and long history of reliable service, we rate this product as Recommended.

GENERAL ECOLOGY NATURE PURE QC-2

General Ecology's Nature Pure QC-2 (see PS October 2013 online) is a smaller version of the Seagull IV, and it has a simpler housing, but the filtration quality is equal. The price ($110 for the element, $286 for the system) is cheaper.

Bottom line: Because of its long history of reliable service, we Recommend this unit.

FILTERS TO AVOID

We reviewed several products that we regarded as overpriced, ineffective, or simply impractical for our purposes. They are representative of many similar filters to avoid.

3M US-B1

The US-B1 by 3M is a proprietary housing design from the multinational 3M. It spills less than others during filter changes, but at $89 per filter and $143 for the system, that's a lot to pay to avoid a few drops in the bilge.

Bottom line: We don't like proprietary elements, which lock you in to a single brand, but some cruisers use this system and like it.

PENTEK EPM-5C

The Pentek EPM-5C is a basic granular activated carbon (GAC) filter, and we don't recommend any GAC filter because bacteria are known to grow in the elements without continuous chlorination.

Bottom line: Don't buy this type.

Pentek CBC-5

PENTEK C2

A carbon-impregnated, 5-micron pleated element, the Pentek C2 is simply not fine enough to stop cysts and contains an insufficient amount of carbon to be of any real use.

Bottom line: Another example of what not to buy.

PENTEK R30-478

A plain pleated element, Pentek's R30-478 is fine enough to stop cysts, but there is no chlorine removal.

Bottom line: A plain pleated filter is of little use for final filtering.

WATERFILTERS.NET P5-5

The P5-5 from Waterfilters.net is a wound filter. Like GAC filters, this style of filter permits bacteria to grow in the media.

Bottom line: We don't recommend wound elements for tap filtration.

HYDRONIX FILTRATION

The low-priced Hydronix SDC-25-1001 ($2 per filter) was a complete failure in our tests, allowing unfiltered water to enter the stream. We tested two separate units to ensure that it wasn't operator error.

Solids ranging in size from 20 to 40 microns continued to slip past this filter, which is rated to 1 micron. In an effort to save a few pennies, the maker skipped end gaskets, depending on the non-woven material to scrunch and seal to the housing.

Hydronix SDC-25

Bottom line: This is a perfect example of why you need to look up the details and not simply accept the NFS stamp as proof of value.

CONCLUSIONS

We don't see much value in proprietary filter systems. We dislike having to hunt down proprietary refills, and we think it is important to have worldwide availability of parts. There is no need to install filters that will filter far more gallons of water than you will use in a year. You have to remove them for winterizing, and if you use it year-round, you should swap after 12 months anyway.

For most boaters, the 2-by-10 filters are fine. We like the Pentek 3G Slim Line housings, and the 0.5-micron carbon-block filters as a good compromise between water quality and cost.

The FloPlus-10 by Pentek fits standard housings, is NSF-53 certified to remove cysts, and offers all of the flow and longevity we could ask for. This filter is a good choice for U.S. and around-the-world-sailors, as long as the latter disinfect the tank and keep it clean. If you desire greater protection, swap out the FloPlus-10 for the MicroGuard MG-10MCB.

Pentek FloPlus-10

For the ultimate in security—the NSF-P231 certified filters are certified as microbial barriers. They are more expensive, and there are not many to choose from, but the drinking water will be safe. Period.

When cruising in areas of questionable water, always chlorinate and filter. This belt-and-suspenders approach is better than getting sick. No matter which filter you chose, leaks are possible, and the downstream pipes can become infected. In order to ensure that you are fully protected, be sure to also read the two previous articles on this topic in the June 2015 and July 2015 issues online.

CONTACTS

DOULTON CERAMIC FILTER, 800/696-1435, www.doultonusa.com

FILTERSFAST (distributor), 866/438-3458, www.filtersfast.com

GENERAL ECOLOGY, 800/441-8166, www.generalecology.com

Kx TECHNOLOGIES, 203/799-9000, www.kxtech.com

PENTEK, 262/238-4400, www.pentairaqua.com

A Second Look at Safety Gear

ACR's LED Firefly Pro Waterbug (above, right) activates under water. The LED draws less power than xenon strobes, like this old West Marine model (left). The Firefly's molded markings were invisible until we highlighted them with a permanent marker (inset).

We recently checked out some equipment that illustrates the challenges of designing and marketing new safety gear, one of the more tightly regulated sailing-equipment categories.

ACR FIREFLY PRO WATERBUG

Made by ACR Electronics, the Firefly Pro Waterbug ($54) is a water-activated, personal strobe light for locating man-overboard victims. The latest version of a 35-year-old product, it features several updates. Power-saving LEDs have replaced the xenon strobe, the orange body is now neon yellow-green, and the light has four modes: water-activated strobe, manually activated strobe, manually activated SOS strobe, and flashlight. (Having flashlight and strobe is handy, but complicates tracking of battery life, not ideal for emergency use.)

ACR advertises 3.5 miles of visibility and 56 hours of battery life. These lab-tested claims are optimistic in real-world use. Our test unit did not last 24 hours on a set of new AA alkaline batteries, and its visibility was less than 1.5 miles, no better than prior units we've tested (see *PS* July 1, 2001 online for a detailed report on rescue lights). ACR suggested we test another unit because, they said, ours was a "pre-production" unit, one of many given to reporters at a boat show. We will update performance data from a store-bought unit that we are currently testing; look for the results in an upcoming issue.

Bottom line: We are hesitant to recommend the light until our followup performance tests are complete. Stay tuned.

GLOWFAST TETHER

The most intriguing feature of Glowfast Marine's Glowfast safety tether isn't its glow-in-the-dark striping; it's the high-load release system that allows the wearer to free himself in situations when a standard snap shackle would fail to open (something *PS* explored in the April 2011 issue; see online). Using a slip-ring release similar to what's used in extreme sports and parachutes, the Glowfast is the only tether we've tested that releases effortlessly at loads over 250 pounds. The problem is that once you trip the release, you're advised to take it to an authorized dealer so it can be "repacked." However, you can repack it yourself—we did—and Glowfast's website links to a video that shows how to do it.

What caught our attention was the lack of a snap shackle at the harness end. This keeps cost down, but should you need to release yourself in a non-emergency—disentangle yourself from a genoa sheet, for example—you cannot quickly clip yourself back in. Testers also noted that the release can trip accidentally in confused conditions on deck, when you need it most.

Bottom line: If you like the Glowfast tether concept, add a snap shackle at the harness side.

The Glowfast incorporates fluorescent striping with an emergency quick release (far left).

The BoatUS rental EPIRB service was outstanding. However, in our view, the instructions should be waterproof laminated, not just sealed in a Ziplock bag.

BOATUS EPIRB RENTAL

Although the price of a 406 EPIRB has dropped in recent years, a new one still runs about $500. But what many buyers don't figure into that equation is the cost of a battery replacement, which can be as much as the unit itself. One alternative to buying an EPIRB, for those who cruise infrequently, is renting one from BoatUS.

We rented a McMurdo Category II G5 from BoatUS for $65 per week; it retails for $465. Rental was dead simple. Service was quick and responsive.

Our only gripe is with the instructions, which are in a Ziplock baggy inside a tamper-proof box. In our opinion, two sets of activation instructions should be given, one with the box, outside for review, and one inside the box, in case the one outside is lost. Both should be laminated.

Bottom line: BoatUS's EPIRB rental service is efficient but could be improved with minor tweaks.

CONTACTS

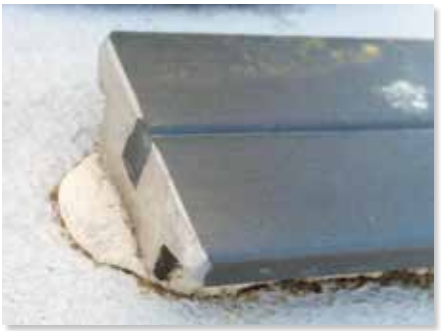
ACR, 800-432-0227, www.acrartex.com

BOATUS, 888/663-7472, www.boatus.org/epirb

GLOWFAST, www.glowfast.com

Low-priced PLS40 Caulk Onboard

By Drew Frye



Some boat projects where we've used Loctite PLS40 successfully have included many re-bedding jobs, upgrading the helm step (right), and installing the genoa track (above). Both photos were taken four years after the projects.

We usually use 3M polyurethane caulks for boat projects: 5200 for permanent fixes, or 4200 if it's something that might need servicing later. The 3M products are impressive but are too expensive for use around the house. About 15 years ago, while looking for something better than silicone and latex caulks for general use, I noticed Loctite's PL line of caulks and decided to give them a try, thinking they might be useful for some on-board applications.

We first tried the Loctite PLS20, a self-leveling concrete crack sealer, on some leaks in the basement. The product seeped right in, curing to a very tough rubber that remains watertight five years later, despite continuing movement and passing winters. We imagine it might be very good for stubborn on-board deck leaks, but it is too runny for most boat applications. There also is a black roof and flashing sealant (PLS30) that, as far as we can tell, is exactly the same as the window, door, and siding sealant (PLS40), except that it is black.

The PLS40 sealant seemed just like 3M's 4200, but with the slow cure of 5200; it is white, messy, and slow curing, but tenacious. While not manufacturer-rated for submerged service, the PLS40 did pass ASTM C1247, "Standard Test for Durability of Sealants Exposed to Continuous Immersion in Liquids"—perhaps Loctite is simply being very conservative. We used PLS40 to patch a fish-pond liner 10 years ago, and the fish are still happy. It carries a 20-year warrantee from a reputable company, and the manufacturer specs fall right in between 3M 5200 and 3M 4200.

After having success with these home experiments, we started using PLS40 on boats about 10 years ago. In practice, we simply can't tell the difference between it and marine adhesives; it bonds, cures, and handles the same. In really tough UV exposures, we see some weathering at 10 years—about the same as 3M 4200—but nothing close to failure. Inside the joint where it matters, 20 years of service seems realistic.

At just $6 for a 10-ounce tube, it's affordable enough to keep a full size tube on hand for many uses around the house and the boat, and quit fooling with the overpriced, 3-ounce tubes. As any polyurethane user knows, once a tube is opened, even if the tip is well sealed with aluminum foil and kept in a cool place, it is still only good for about two months.

Tip: If you have an off-season project requiring polyurethane, and the adhesive just won't cure in a dry, heated winter house (water is the curing agent for most polyurethanes), place the project in a large cooler or other sealed container with a damp towel and a heating pad. It will cure just fine, like it's summer. Polyurethanes require warm, humid conditions to cure properly.

Bottom line: We still recommend premium 3M and Sika adhesive products for critical applications (see *PS* August 2010 online), but with characteristics between 3M 5200 and 3M 4200, the Loctite PLS40 has not let us down, and it costs one-third of the price. At the very least, we Recommend trying it at home.

PS VALUE GUIDE LOCTITE PLS40 vs. MARINE ADHESIVES

PRODUCT	LOCTITE PLS40 ✓	3M 5200 ✓	3M 4200 ✓	SIKAFLEX 291 LOT ✓
COLOR	White	White	White	White
TEMPERATURE RANGE	-40 to 180 degrees	-40 to 190 degrees	-40 to 190 degrees	-10 to 80 degrees
CURE (1/4-inch)	7 days	7 days	2 days	7 days
TENSILE STRENGTH	415 psi	885 psi	180 psi	120 psi
HARDNESS	30 Shore A	58 Shore A	40 Shore A	42 Shore A
ELONGATION TO BREAK	950 percent	1,200 percent	>400 percent	700 percent
BELOW WATERLINE	No	Yes	Yes	Yes
PRICE (10 oz. tube)	$6	$15	$22	$16

✓ Recommended

CONTACT: LOCTITE, 800/624-7767, www.loctite.com

Photos by Drew Frye

AGM Batteries Test Update

The tall, blue Northstar/Energy1 battery (on right) might require some modification to battery boxes or compartments to fit.

East Penn (again) and Northstar submit to the PS *torture test.*

In our recent test of absorbed glass mat (AGM) batteries, we cycled five different batteries through 30 deep cycles to 11.7 volts but only partially recharged them for one hour after each discharge cycle at a charge rate of 46 percent of battery amp-hour capacity. (See *PS* May 2015 online.) The object of the exercise was to demonstrate just how quickly sulfation, which is caused by keeping a battery in a partial state charge (PSOC), can reduce the capacity and eventually permanently ruin a good battery.

The discharge-recharge cycles were designed to mimic the recharging routine of a sailor who relies solely on his engine alternator to recharge his batteries when anchored. After completing 30 cycles, we used a multi-stage charging process to bring the batteries back up to full capacity. We then compared the capacity of each battery to its original capacity, before the partial state of charge test began. Some of the new absorbed glass mat batteries in our test never fully recovered to their pre-test capacity—and one in particular, the Deka 8ADTM, recovered a far smaller percentage of its original charge than the others.

To double-check our findings, we decided to test a second Deka 8A31DTM. We also wanted to test a thin-plate, pure lead AGM battery that we missed in the first round, Northstar Battery's Energy1 NSB-115-FTB (also sold as the Northstar NSB-100-FT Blue+). We had only one thin-plate, pure lead (TPPL) AGM in the first round, the Enersys Odyssey PC2150, and it earned a Recommended rating.

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. It is sold by Deka, West Marine, NAPA, and many Sam's Clubs as a Duracell, O'Reilly Auto, Power-Tec, MK Battery, and 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. Our second Deka test battery tested slightly below its rating with a baseline capacity of 104.8 amp hours. The first Deka tested at 104.5 amp hours; this shows good manufacturing consistency. Netting 104.8 amp hours from a 105-amp-hour battery is certainly an acceptable baseline capacity.

With each recharge during the partial state of charge testing, the Deka 8A31DTM's usable capacity (in amp hours) walked down at a reasonable pace compared to others, although it was slightly below its sister battery. It handled the partial state of charge cycling fairly well in terms of "walk down." Its lowest usable capacity, after the one-hour recharge during the 30 PSOC cycles, was 35.88 amp hours; that's a walk down loss of 10.57 amp hours over 30 PSOC cycles. (See accompanying chart.)

At the end of the partial state of charge testing, however, this 8A31DTM, like its sister battery, had lost a large percentage of its original 104.8 amp-hour baseline capacity. Even after three capacity tests,

Photos by Rod Collins

PS VALUE GUIDE GROUP 31 MARINE AGM BATTERIES

MANUFACTURER	DEKA	FIREFLY	ODYSSEY	LIFELINE	NORTHSTAR/ENERGY1
MODEL	8A31DTM	FF12HR1-G31	PC2150 ✓	GPL-31T ✓	NSB-100-FT Blue+/ NSB-115-FTB ✓
PRICE / WARRANTY*	$260 / 12 months	$425 / 48 months	$350 / 48 months	$325 / 60 months	$360 / 24 months (full)
BCI GROUP SIZE	31	31	31	31	Non-standard / Slimline
STATED Ah CAPACITY @ 20 HOUR RATE (C)	105 amp hours	110 amp hours	100 amp hours	105 amp hours	105 amp hours
STATED RESERVE CAPACITY @ 25 AMP DISCHARGE RATE	200 minutes	240 minutes	205 minutes	195 minutes	220 minutes
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	14.4 to 14.7 volts
MARINE CRANKING AMPS @ 32 DEGREES	1,000 amps	850 amps	1,370 amps	750 amps	1,150 amps
COLD CRANKING AMPS @ 0 DEGREES	800 amps	750 amps	1150 amps	600 amps	820 amps
WEIGHT	69 pounds	70 pounds	77.8 pounds	64 pounds	76 pounds
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	15.6 x 4.2 x 11.3 inches
TERMINAL TYPE	Stud & lead post	Bolt	Stud	Bolt & brass post	Bolt
TEST RESULTS					
BASELINE CAPACITY	104.8 amp hours	110.02 amp hours	105.8 amp hours	105.2 amp hours	108.2 amp hours
AMP HOURS CAPACITY AFTER 30 PSOC CYCLES	76.04 amp hours	110.51 amp hours	98.96 amp hours	93.02 amp hours	98.97 amp hours
AMP HOURS SPREAD OVER 30 PSOC CYCLES	-10.57 amp hours	-14.65 amp hours	-9.93 amp hours	-14.03 amp hours	-12.3 amp hours

✓ Recommended

*Pro-rated after first year, except where noted; some rebranded Dekas offer longer warranty terms.

the 8A31DTM could deliver only 76.04 amp hours. While this was a gain of 2.62 amp hours beyond the first 8A31DTM we tested, it still represents a surprisingly high capacity loss. As a result of the partial state of charge testing, the second battery lost approximately 27 percent of its original tested capacity.

In our first test, Deka suggested that our capacity testing did not bring the battery up to full capacity for our post-PSOC capacity testing. This time, we made sure everything was done exactly to Deka's specifications. The second and third capacity tests were done to 0.30-amp charge current at 14.6 volts, and we returned in excess of 110 percent of removed capacity per Deka's recommendation. After the tail current dropped to 0.5-amps and 14.6-volt absorption voltage, we had returned 110 percent of removed capacity; but we kept charging until the tail current pushed toward 0.3 amps.

The second battery was also float-charged for two full days after absorption charging at 14.6 volts to 0.3 amps (the accepted charge current). After 48 hours of float charging, we rested the battery for 24 hours and capacity tested it again.

Bottom line: We are still perplexed at the capacity loss on the second Deka battery when compared to the other AGM batteries tested.

ENERGY1 NSB-115-FTB / NORTHSTAR NSB-100-FT BLUE+

Northstar Battery is a relatively new company. Its batteries utilize thin plate, pure lead technology similar to EnerSys/Odyssey. The company is well ensconced in the telecom, UPS, marine, transportation, and industrial battery fields. We tested a newer technology by Energy1/Northstar called the NSB+ or "blue plus" battery.

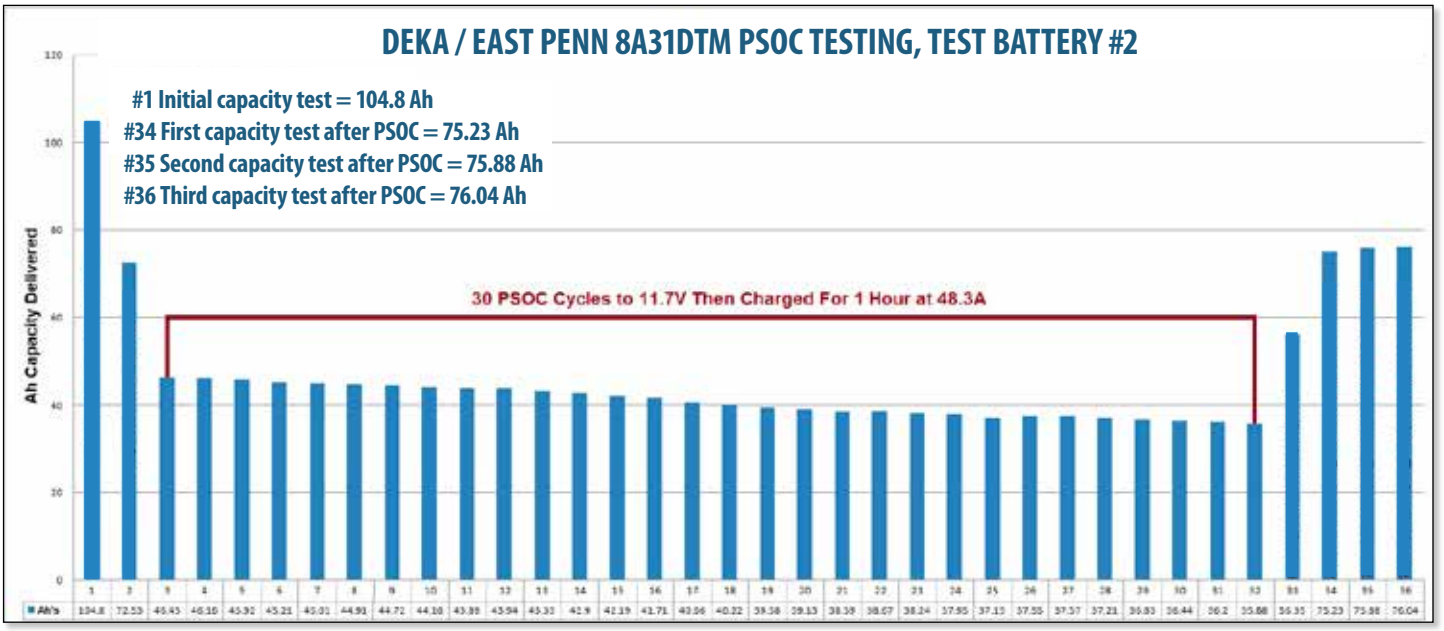
Our test battery was supplied by Energy1 and labeled as an Energy1 NSB-115-FTB; we were told that this is the same battery as the Northstar NSB-100-FT Blue+. We saw no wide difference between advertised street prices for the two batteries, but depending on who distributes and sells the battery in your area, you may get better pricing on one or the other.

Northstar claims that the NSB Blue+ technology can recharge five times faster than other AGMs and deliver up to three times the cycle life due to its PSOC-resistant design. This was one of two newer technologies we have tested specifically engineered to endure partial state of charge use; the carbon-foam Firefly AGM, which performed very well in our first round of tests, was the other one.

The NSB-115-FTB is rated at 105 amp hours (20-hour rate) and is a "slim-line" case design, not a typical Group 31 like the other AGM batteries we tested. Some boats may require modification to fit the different form, which is 4.2 inches wide by 11.3 inches tall by 15.6 inches long.

Thin-plate batteries are more commonly used for cranking applications (starting engines), but Northstar and Odyssey have been using thin-plate batteries for deep-cycle applications for a while. According to the makers, the pure lead is what allows them to build a thin-plate battery that endures deep-cycling, and at the same time, provide for massive cranking ability as well.

The NSB-115-FTB TPPL AGM test battery tested above its 105-amp-hour rating; it started with a baseline capacity



The Deka 8A31DTM's usable capacity (in amp hours) walked down with each partial recharge from 46.45 amp hours at the start of testing to 35.88 amp hours at the end of the 30 partial state of charge cycles.

of 108.2 amp hours.

The Energy1/Northstar battery's walk down was comparable to the other batteries. Like the Firefly, it had some peaks and dips along the way. (See PSOC table online.) At the end of the partial state of charge capacity testing, however, the NSB-115-FTB could not get back to its baseline, as-new capacity. After three post PSOC capacity tests, it delivered a high of 98.97 amp hours. For testing purposes, this represents a capacity loss of approximately 8.5 percent.

It should be noted that Energy1, whose sticker is on the battery, recommended charging at 14.7 volts at 77 degrees, but Northstar, the maker of the battery, suggested a lower voltage. Stuck in the middle between the manufacturer and the private labeler, we settled on a compromise voltage of 14.6 volts. We suspect that at 14.7 volts, the battery may have done slightly better.

Bottom line: Overall, the Energy1/Northstar handled the partial state of charge cycling fairly well, certainly better than the Deka. It claims to be a PSOC-tolerable battery, but it still fell short of the Firefly, which completely recovered from the PSOC testing in our first round of tests. The Energy1/Northstar battery is comparable to the Odyssey TPPL AGM, in terms of overall capacity loss from PSOC testing.

Editor's Note: The online version of this article includes links to the complete PSOC test data for these two batteries as well as the original group for comparison.

CONCLUSION

No single test can replicate the many permutations of charge and discharge cycles that happen on a cruising sailboat, but that was not the purpose of this test. This test focused on a very narrow, albeit important, performance factor: a battery's ability to recover from partial state of charge use.

This test update gives us confidence that our initial findings with the Deka AGM were not a fluke. The battery does not recover from partial state of charge abuse as well as some of its competitors. In spite of these findings, the battery's rock-bottom price, wide distribution, and warranty support make it an attractive option for sailors whose bad habits and sub-standard charging setup will kill whatever battery they use.

A conscientious sailor who follows the advice we gave in part one of this report will get more life out of one of our Recommended batteries (see table), so the extra upfront cost for one of these more expensive AGMs will pay off.

The Northstar competes almost equally with the Odyssey battery, so your choice may come down to which battery is more widely distributed in your area, the price, and what sort of warranty is offered by the distributor.

This inside view of two 225-Ah AGM batteries, with the tops removed, reveals the very fine fiberglass mat that encapsulates the battery acid, effectively making the batteries spill-proof.

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

NORTHSTAR, 417/575-8200, www.northstarbattery.com

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

Watering Batteries

A search for trusted sources.

Our May 2015 report on absorbed glass mat (AGM) batteries got us thinking about wet cell-batteries. While it is easy to find distilled water suitable for topping off the battery electrolyte in the U.S., what happens when we are not near a reliable supply? Are there any substitutes? What should we avoid?

We compared what the manufacturers recommend for new batteries coming out of the factory with what they recommend for topping off. We also looked up standards for water used to blend engine coolants. (See table.) It turns out that engine coolant specifications are just as stringent as those for topping off a battery.

In our quest to identify safe and unsafe sources of water for our battery and engine, we were most interested in the total dissolved solids (TDS) of the water. Total dissolved solids is calculated from conductivity and is a measure of dissolved ions in the water, including calcium, chloride, sulfate, and carbonate. Although battery manufacturers allow up to 100 parts per million (ppm) TDS for topping off, manufacturing standards are much lower (10 to 18 ppm). We suggest following the latter guideline.

For our test, we also recorded pH levels to determine acidity. We used a TDS meter and simple pH strips to compare samples; both of these are handy, relatively inexpensive tools that are worth having for long-term cruising. (See *PS* July 2015 online.)

We tested more than a dozen water samples, including multiple distilled-water samples from neighborhood stores, rainwater, onboard and home air-conditioning condensate, dehumidifier condensate, home and onboard reverse osmosis (RO) water systems, plain tap water (home and marina), and bottled drinking water.

All of the distilled water and rainwater samples we tested were less than 10 ppm TDS. Our rainwater samples were taken in a well-protected seawater harbor; if there was more spray, the result would be different.

Reverse-osmosis water from a residential tap was 17 ppm, and dehumidifier water was less than 30 ppm, suitable in a pinch. Other samples surpassed the recommended levels.

The fact our onboard air-conditioner condensate showed a high 74 ppm didn't surprise us, since salts present in the water source will concentrate in the condensate as the water is recycled through the system. Our home central AC system also had high TDS: 80 pps.

Seawater RO systems make good drinking water, but in terms of dissolved solids (chloride, in particular), the product is far worse than tap water; the systems we tested, from several boats, showed an exceptionally high 200 to 500 ppm TDS. Bottled drinking water, which showed 110 ppm in our tests, is simply purified tap water or well water and is equal to or worse than tap water when it comes to TDS. Our tap water samples showed 140 to 240 ppm TDS. Avoid using these for battery or engine water. All of the water samples we tested had acceptable pH.

Bottom line: Distilled water is the safest and easiest answer for boat batteries and cooling systems. However, rainwater, home RO water, and dehumidifier condensate are certainly acceptable, giving the cruiser a few more options for water sources when topping off the batteries.

PS TEST RESULTS BATTERY WATER

TESTED WATER	BATTERY WATER SPECS			ENGINE COOLANT WATER SPECS	TAP WATER (TYPICAL RANGE)
BATTERY	TROJAN BATTERIES	EXIDE BATTERIES	ZVEI +	ASTM D3306	
COLOR	Clear and white	Clear and white	Clear and white	N/A	Clear
CONDUCTIVITY	158 uS/cm **	158 uS/cm **	30 uS/cm	79 uS/cm	100-1000
pH	N/A	N/A	5-7 ppm	5.5 - 8.5 ppm	6-8.5 ppm
SUSPENDED MATTER	Trace	Trace	N/A	N/A	0-5 ppm
TOTAL DISOLVED SOLIDS	100 ppm	100 ppm	18 ppm**	50 ppm***	60-600 ppm
ORGANIC AND VOLATILE MATTER	50 ppm	50 ppm	20 ppm	N/A	2-25 ppm
AMMONIA	8 ppm	5 ppm	40 ppm	N/A	N/A
ANTIMONY	5 ppm	N/A	0.1 ppm	N/A	N/A
ARSENIC	0.5 ppm	N/A	0.1 ppm	N/A	N/A
CALCIUM	40 ppm	20 ppm*	0.1 ppm	9 ppm*	25-300 ppm
CHLORIDE	5 ppm	5 ppm	0.5 ppm	25 ppm	10-200 ppm
COPPER	5 ppm	N/A	0.1 ppm	N/A	0-0.5 ppm
IRON	3 ppm	4 ppm	0.1 ppm	1 ppm	0-0.3 ppm
LEAD	N/A	N/A	0	N/A	0
MAGNESIUM	40 ppm	5 ppm*	0.1 ppm	3 ppm*	5-150 ppm
NICKEL	None allowed	N/A	0.1 ppm	N/A	N/A
NITRATE	10 ppm	10 ppm	2 ppm	N/A	0-5 ppm
NITRITE	5 ppm	5 ppm	N/A	N/A	N/A
PLATINUM	None allowed	N/A	N/A	N/A	0-0.2 ppm
SELINIUM	2 ppm	N/A	0.1 ppm	N/A	N/A
SULFATE	N/A	N/A	N/A	50 ppm	20-250 ppm
ZINC	4 ppm	N/A	N/A	N/A	0-2 ppm

* Limit stated as CaO + MgO; recalculated as Ca and Mg at typical ratio. ** Approximate equivalence between TSS and conductivity *** Typical + German Electrical Trade Association

Photo by Drew Frye

Tormented by hundreds of no-see-um bites (above right) while cruising French Polynesia, cruising sailor and PS contributor Patrick Childress and his crew experimented with onboard concoctions to ease the itch. Acetone and dish soap were the most effective.

Necessity Breeds Innovation

Cruisers find homemade cures for incessant itching from no-see-ums.

By Patrick Childress

Those who use citronella or Skin So Soft for an insect repellent will not appreciate these high-octane anti-itch remedies. But it is safe to assume that such a conservative attitude is reserved for those who are not in the thick of battle with a foe as formidable (and miniscule) as battalions of Lilliputians.

There are many cruising grounds where biting insects are a serious menace, not just because of the initial discomfort and ensuing itchy torment, but also because of the potential longer-term health effects of viral, insect-spread diseases like chikungunya, zika, and dengue fever, which seemingly have been on the rise the last few years in tropical latitudes around the world. In these areas—the Caribbean, French Polynesia, etc.—only large slathers of powerful DEET repellents have any hope of keeping mosquitoes and biting gnats (sand fleas or no-see-ums) from gnawing on exposed skin. Nothing can kill the romance of a majestic, remote, volcanic beach in French Polynesia like a cloud of no-see-ums.

So what do you do if your DEET defenses are breached? "Don't scratch" is the simplistic advise from one cruising book. This is no easy task, and the terrible irritation of a tropical no-see-um or mosquito bite can last up to a week, if untreated. But a simple rub of one bite can quickly become a fingernailed dig to rid the increasing irritation as the saliva left behind by the bug works like a pocket of flesh tenderizer under a thin cap of skin.

Each mosquito and no-see-um species has its own unique anticoagulant saliva makeup, so each itch relief treatment will have somewhat varying results, and each person might have a different level of allergic reaction to the bite. Experimenting with different remedies is the best approach.

While cruising French Polynesia recently, our crew suffered horribly from scores of stealthy-insect bites, which appeared like a rash. Over-the-counter and natural remedies, like the locals' suggestion of coconut oil, simply did not work. Out of sheer desperation, we began experimenting with any liquid, powder, and paste close at hand. There were numerous failures and near-misses, but then we got results.

The first that showed great promise was dishwashing soap. It had to be a thick, high-quality product, not the watered down stuff popular in South American grocery stores. Undiluted and applied directly to the bite, the dishwashing detergent offered relief that would last for hours, but it would eventually need reapplication. A cruising American medical doctor we met supported our findings, and had even included dish soap as an anti-itch solution his book, "Your Offshore Doctor."

The second, and slightly more effective itch treatment was to swab full-strength ammonia directly onto the irritations. The relief easily lasted a half-day, often times overnight or even permanently.

The most effective solution we found was acetone. While acetone is a naturally occurring substance in the human body, it should not be slathered on the skin. It only takes a small dab on the bite, and within moments, the itch is usually permanently neutralized. In our experiments, we found acetone to be the real itch eraser, compared to the other treatments. Note that the MSDS for acetone advises against skin contact; if you have sensitive skin, we do not recommend putting acetone on it.

Desperate situations often require desperate remedies. As with any home remedy that's not OK'd by the U.S. Food and Drug Administration (FDA), use your best judgment and weigh the health benefit-to-risk ratio when seeking anti-itch solutions to stop the torment. If you have any other DIY, homemade itch stoppers, let us know about them; email practicalsailor@belvoir.com.

Photos by Patrick Childress

ON THE HORIZON
BOAT REVIEW: C&C 33
2015 EDITOR'S CHOICE PICKS
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Anchor Chain and Shackles

Choosing the right shackle for your anchor rode.

I've been studying your recent articles on chain and galvanizing (see *PS* June 2014 and January 2015 online), as I am about to replace the anchor chain on my catamaran. When it to comes to the shackles, I am confused.

If I use 3/8-inch Acco G43 proof-coil chain, why is the same-size galvanized shackle so much weaker? West Marine shows the Acco G43 chain rated at 5,400 pounds maximum working load (MWL), but the similarly sized shackle is rated at only 2,000 pounds MWL. It seems as though whatever size chain I select, the shackle is the weak link. How can I use a larger shackle on smaller chain?

Steve Wann
Tonic, Catana 431
Virginia

PS ADVISOR

Comparing specifications between two different types of products can get confusing. Part of the problem here is the data you're comparing. The products' working load limits (WLL) and MWL are derived from the safety factors used in their manufacture. Because chain and shackles are made using different safety factors, their maximum working loads aren't directly comparable. (For a more detailed explanation of safety factors, see "Anchor Shackles: The $15 Insurance Policy" in this issue.)

Shackle specifications use safety factors ranging from 6:1 to 4.5:1 (depending on maker and size); however, the factors are degraded by 50 percent if the shackle is loaded at a 90-degree angle. G43 chain is made using a 3:1 safety factor; there is no variation for angle of pull.

Because of these very different safety factors, they seem very far apart in terms of strength, but if you compare their minimum breaking strength (MBS), the shackle is nearly as strong as the chain. The minimum breaking strength of 3/8-inch G43 chain is 16,200 pounds (3:1 safety factor). The minimum breaking strength of 3/8-inch Peerless and Campbell shackles are 24,000 pounds or 12,000 pounds (6:1 safety factor) at a 90-degree load, depending on the shackle grade (see below) and size. Crosby shackles, which work to a 4.5:1 safety factor, have an MBS of 18,000 pounds to 9,000 pounds.

Shackles are graded according to strength: More common Grade A (3/8-inch) shackles have a WLL of approximately 1 ton, and Grade B shackles have a WLL of approximately 2 tons. (WLL varies by size.) Makers distinguish their shackle grades by coloring the pins: For example, the Crosby uses silver; Peerless (Peer-Lift line) uses blue pin; and Campbell uses orange.

If you use the 3/8-inch Acco G43 chain, we highly recommend going with a Grade B bow shackle one size up. The Peer-Lift Grade B 7/16-inch shackle should fit the hole in 3/8-inch chain and has an MBS of 32,000 pounds, almost double that of the chain (16,200 pounds). This means the shackle and chain will have similar strengths in worst-case scenarios (i.e. side loading the shackle), but in most situations, the shackle will be twice as strong as the chain. If you want overkill, the half-inch shackle likely will fit the chain also.

Always use a galvanized, "rated" bow shackle for the anchor rode. (Bow shackles articulate better.) Rated shackles have the WLL stamped on their body, along with the country of origin, a code indicating when the shackles were made and by whom, and their size (i.e. 3/8 inches). These shackles are batch tested for failure, and most—at least those made in Europe and the U.S.—are also proof tested (tested to twice the WLL). No stamped rating means there's no way to know whether it was tested or what its WLL should be. Trusting ground tackle to a shackle with unknown pedigree is asking for problems.

Crosby (*www.thecrosbygroup.com*), Peerless (*www.peerlesschian.com*), and Campbell (*www.campbellchainandfittings.com*) are the most easily accessible shackle brands in the U.S. All offer galvanized, rated bow shackles. You'll find these brands at most chandlers or local lifting-gear specialists that sell lifting cables, chain, and fittings.

In addition to strength compatibility, you'll need to check that all ground-tackle components physically match; this includes the windlass gypsy. Shackle and chain dimensions can vary from maker to maker, so it is essential to check. Cut off a link of your chain, and take it with you when shackle shopping; take the windlass gypsy along when chain shopping; or buy the whole lot at the same time from the same place.