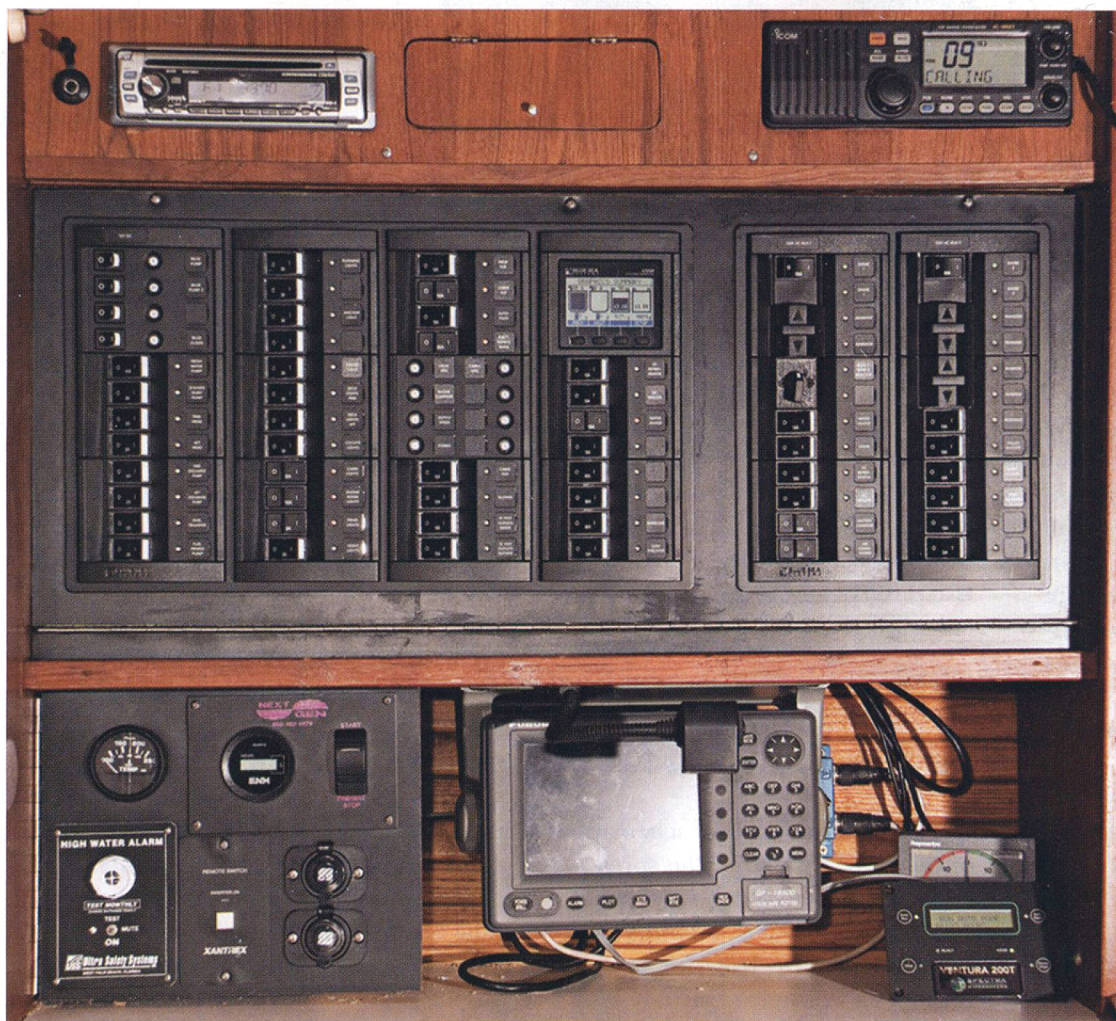


« BOAT KEEPER »

EDITED BY PIERCE HOOVER



obstacle may be navigating American Boat and Yacht Council (ABYC) recommended standards. “Electricians are familiar with the standards: where to run wire harnesses, how to protect wires from chafe, fittings on bulkheads that preserve structural integrity,” says Steve Treaster, the inside service manager at Ward’s Marine Electric in Fort Lauderdale (wardsmarine.com). Adequate wire size, appropriate circuit breakers and reverse-polarity indicators are also important. “With the supervision of an electrician, these kinds of projects can be done by the average boat owner,” Treaster says. Even the most experienced marine electrician, however, can’t organize the panel as well as a boat owner who understands when and how electrical equipment

is used on that particular vessel.

Off-the-shelf or custom electrical panels are available from Paneltronics (paneltronics.com), Bass Products (bassproducts.com), Newmar (newmarpower.com) and

Panel Prognosis

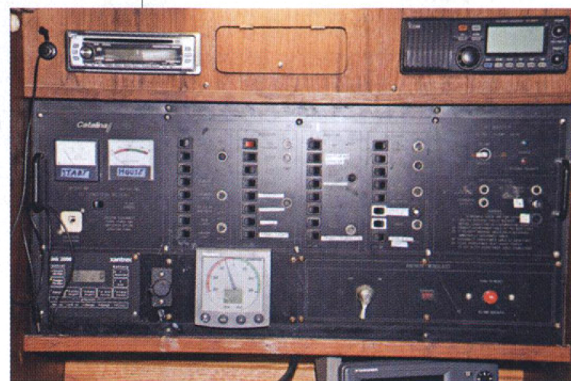
New life for an overburdened electrical system.

BY CAPT. VINCENT DANIELLO

As boating horizons expand, many an aging but beloved weekend cruiser is pressed to do more. Short trips to marinas may give way to longer voyages with many nights on the hook. Additions such as a generator, inverter and water-maker can increase self-sufficiency but can also put a strain on wiring systems, because the boat’s existing electrical panel may not be able to accommodate this new equipment. Adding subpanels may over-

come the immediate problem, but at some point the best option is to install a brand-new electrical panel.

To understand what’s involved, we’ll take you through the planning and installation of a new panel, with advice from experts along the way. While this is definitely a big project, it doesn’t have to be daunting. The biggest

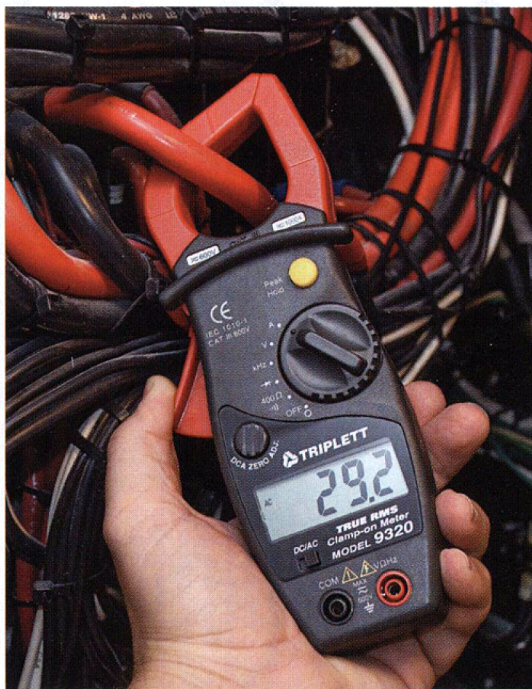


BEFORE AND AFTER. The new panel (top) not only updates its predecessor (above), but also allows for additional circuits and devices.

others, but it was Blue Sea Systems' modular 360 panel that best fit our project (blueseasystems.com). "I don't think anyone has as flexible an architecture as we have," says Scott McEniry, sales operations manager and an engineer at Blue Sea. Individual square modules, available in many configurations, are attached to one underlying frame. "We can even put C-series breakers, up to 300 amps for windlasses and bow thrusters, right in the same panel as standard breakers. It really allows the boat owner to customize to the boat's needs."

For our project, we opted for individual on/off breakers for lighting and equipment, but to save space we powered electronics with push-to-reset breakers — eight individual circuits in the space of four normal breakers. Mix-and-match modules from Blue Sea include gauges, 12-volt DC outlets and even blank faces for custom equipment mounting.

With this flexibility, individual choices come down to available space. "List how many breaker positions you'd like to have, and then see what you can make work with different modules," McEniry suggests. Our plan began with a sketch of what we had and a list of what was needed, including room for future expansion. An Excel spreadsheet organized the project through planning, working drawings



MULTIMETER MAGIC. A clamp-on multimeter can calculate amperage drawn through a wire by measuring the strength of its magnetic field. Be sure to measure amperages with batteries fully charged but chargers turned off, and use the meter's maximum-hold feature to record startup loads.

and even a final "as built" schematic of the panel. We sized the spreadsheet to half-scale of our panel opening, and made columns and rows to measure half the size of Blue Sea's breakers. This not only helped us visualize panel organization, but it also ensured we stayed within available space.

To aid planning, our spreadsheet also included continuous and start-up

amperage for each circuit, either measured with an ammeter or taken from spec sheets. Treaster helped calculate necessary breaker sizes from these specific loads. We also listed all existing or required wire sizes on the spreadsheet, since the circuit breakers are primarily there to protect wires. We combined two 10-amp cabin light circuits from the old panel into one 20-amp breaker, for example, but only because those individual wires were 12-gauge. Had they been smaller (14-gauge or 16-gauge), the wiring might catch fire

before an electrical short would trip a 20-amp breaker. (See sidebar on minimum breaker sizing below.)

Incoming main power cables also must be sized to accommodate the increased electrical demand of systems added to the panel, and must have appropriate fuses at their source. Direct-current circuits generally use one large cable running from the battery selector switches to the panel. Electronic engine circuits are typically isolated with their own DC power, wired directly into and out of ignition breakers on the panel. We opted to similarly isolate bilge pumps, so they'll stay on even when main battery switches are turned off.

We kept alternating current panels separate from DC panels, both to meet ABYC recommendations and to facilitate connections behind the panel. It's also important to balance AC loads — having two shore cords provides no benefit if one is overworked while the other is idle. To accomplish this, take the time to think through the anticipated equipment use and configuration and refer back to amperages recorded on the spreadsheet while planning your layout.

Once a seemingly workable plan is in place, consult an electrician.

Wire Sizing

Required minimum wire size is calculated based on voltage, amperage drawn, resistance created by the length of wire and allowable voltage drop for equipment type. This can be calculated with Blue Sea Systems' online Circuit Wizard (www.beta.circuitwizard.blueseasystems.com). Circuit breakers are similarly chosen based on load and equipment, but for a given wire size, regardless of length, there are also maximum breaker sizes. Never use wire smaller than 16-gauge to carry power to equipment or lights.

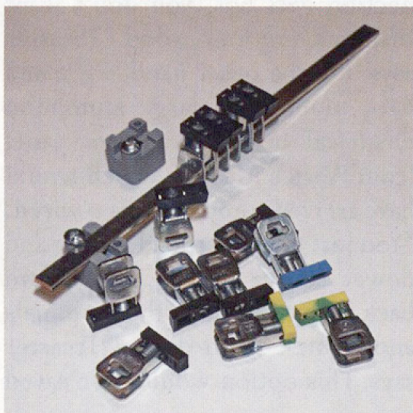
Maximum breaker sizes for all DC or AC circuits:

WIRE SIZE	CIRCUIT BREAKER
16-gauge	10-amp
14-gauge	15-amp
12-gauge	20-amp
10-gauge	30-amp
8-gauge	40-amp
6-gauge	60-amp

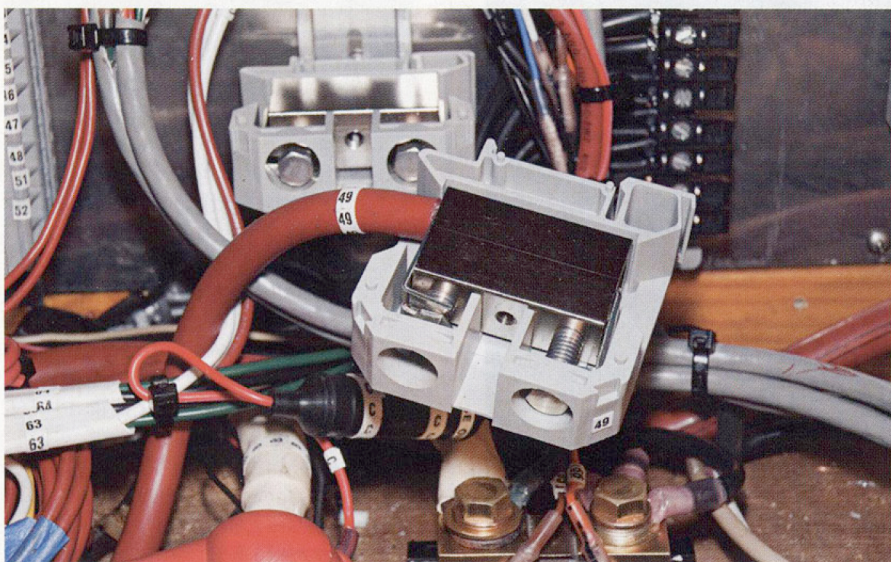
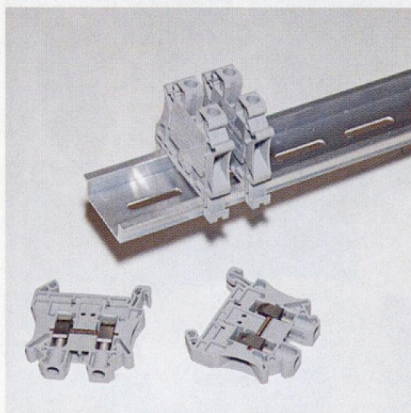
Isolating Bilge Pumps

In the upper left corner of our panel, we connected automatic bilge-pump circuits directly to push-button circuit breakers, which will trip if shorted but cannot be turned off. Manual bilge-pump momentary switches are fed by the same breakers, and LED indicator lights illuminate only when bilge pumps are running. The bilge alarm is also always on, with a momentary switch to test the siren. The power-feed for this corner comes directly from the batteries through a Blue Sea Systems circuit breaker, powering the bilge pumps even with battery selector switches turned off.

Both Blue Sea Systems and Ward's Marine Electric provide simple engineering support when purchasing panels. Treaster's input was invaluable, suggesting Phoenix Contact DIN-rail terminal blocks and bus bars (phoenixcontact.com) that saved considerable time and made for a much neater finished project. McEniry helped clarify our spreadsheet into a final plan for Blue Sea Systems technicians.



McEniry also offered advice on breaker styles, meters and other components. "On our 360 panels, breakers are recessed from the panel face. With flat-rocker breakers, you virtually eliminate accidentally activating or tripping breakers when brushing by," he says. "This eliminates the need for a door." Removing the door and moving the panel out may gain a critical few inches behind the panel. (Treaster



TIME SAVERS. Phoenix Contact products saved considerable time and made for a much neater finished project. Terminal blocks in many sizes snap onto DIN rails, accepting multiple wires in each. Slide-on bus bar connectors are color-coded — black for DC negative, blue for AC neutral and green/yellow for AC ground. (phoenixcontact.com)

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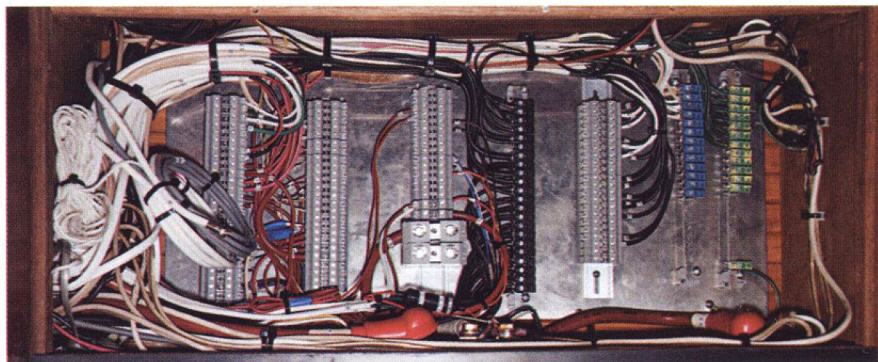


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recommends at least eight inches of depth for wire bundles and terminal blocks needed on a typical 40- or 50-footer.)

With the new panel ordered, we removed the old one, numbering wires based on the new panel's design spreadsheet. The boat's existing wires were too short for clean runs to the new panel, so we installed and wired terminal



FIRST THINGS FIRST. We started with AC wiring on the far side of the panel from incoming wires, and then DC negative wires, since they aren't attached to the panel breakers. Lastly, DC equipment wires were connected with lengths of single-conductor wire, and ring terminals were crimped to one end, numbered, cut to length, stripped and secured in numbered terminal blocks. Be sure to give all wires a final pull test before neatly securing wire bundles.

blocks, mounted on a grounded aluminum plate. "If a loose connection gets hot, you don't want that touching raw wood," Treaster says. On the other hand, we could have mounted a large aluminum electrical box and custom panel from Ward's Marine, which would have arrived completely pre-wired. "You just take your load wiring and power source wiring, strip them back, slip them into the terminals and tighten them down," Treaster says. This option would have saved

The Right Connection

Two-conductor cable — typically one red and one black wire within the outer PVC jacket — is used for DC circuits. Three-conductor cable, with black, white and green wires, works well for 120-volt AC wiring. The glue in heat-shrink terminal ends makes much stronger connections than ends only crimped onto wires. The American Boat and Yacht Council specifies either ring or captive fork terminals on all electrical connections aboard. (Captive forks have upturned tips so they can't easily fall off a loose screw.) Friction terminals are also OK, provided they resist at least a six-pound pull and the circuit is less than 20 amps.

VINCENT DANIELLO (4)

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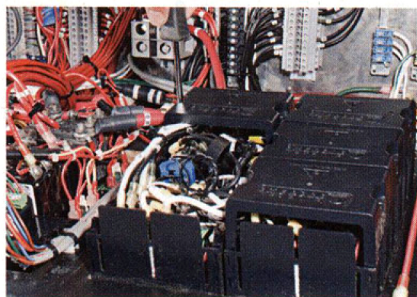
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considerable labor and greatly reduced electrical knowledge required aboard the boat. A pre-wired box can also be built by most electricians using Blue Sea's panel.

When the new panel arrived, the first step was building a stronger frame — our 18-module Blue Sea panel weighed roughly 30 pounds. Black Formica on three-quarter-inch plywood was hinged across the bottom to provide access. Once mounted, AC neutrals and grounds were wired first, and then AC loads since this was farthest from where wires enter the space. DC negative wires were added next, and then DC loads. To connect breakers on the panel to terminals, first crimp ring terminals to lengths of single-conductor wire, number them, cut to length, strip and then secure them in terminal blocks. Give all wires a final pull test before neatly securing wire bundles.

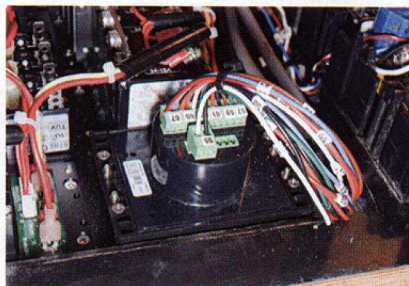
Installing Blue Sea's multifunctional Vessel Systems Monitor (VSM) required the most effort and electrical knowledge. A separate terminal block between AC



ISOLATION. *ABYC recommends isolating AC panel backs. Blue Sea's 360 panel accommodates this with plastic enclosures.*



HOT WIRING. *The blue rotary switch and round black amperage-sensing coil had to be wired after panels were mounted — a tricky step that would be avoided with a pre-wired box and panel.*



BOTH SIDES. *The display (top) and back side (above) of the Vessel Systems Monitor.*

and DC systems behind the panel isolated this complex work and simplified the wire runs needed for both AC and DC monitoring. The VSM provides lots of function in a small package, using far less panel space and costing less than individual volt and amp displays for AC and DC. It also monitors AC frequency, tank levels, a bilge pump and battery state with programmable alarms for all. The VMS is limited to monitoring only one power source, though. Blue Sea provided a rotary switch for monitoring volts, amps and frequency on all AC power sources, but this didn't come pre-wired and was the trickiest part of the job. A custom electrical panel from Ward's would have been completely pre-wired, including meters.

Cleanup after installation is straightforward, with one caveat: Carefully vacuum up all those bits of wire insulation before they clog bilge pumps, and tiny shards of wire that will pierce soft feet and fingers.

In next month's Boatkeeper, we'll focus on the items that a new panel has made possible, such as additional shore cords, generators and inverters.

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