The Ash Breeze

Journal of the Traditional Small Craft Association

Rosemary Wyman's Photography

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Marine Wire

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The Ash Breeze

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The Traditional Small Craft Association, Inc. is a nonprofit, tax-exempt educational organization that works to preserve and continue the living traditions, skills, lore, and legends surrounding working and pleasure watercraft with origins that predate the marine gasoline engine. We encourage the design, construction, and use of these boats, and we embrace contemporary variants and adaptations of traditional designs.

TSCA is an enjoyable yet practical link among users, designers, builders, restorers, historians, government, and maritime institutions.

TAB Layout Design: Karen Bowen
Cover Photo: © Rosemary Wyman

President's Message:

What is "Traditional"?

Marty Loken, President

The trouble with traditions is that they keep changing. One minute you're "in" as a tradition; the next minute, maybe not so much.

Back in the 1970s, when the Traditional Small Craft Association was conceived, the inspiration was a drive by bureaucrats to rule that traditional small boats were no longer considered seaworthy, or legally recognized by the Coast Guard. So a well-informed crew of agitators including John Gardner and Pete Culler, who loved small and traditional rowing and sailing boats and thoroughly understood their seaworthiness and utility, got together and lobbied successfully to prevent bureaucrats from downgrading small-boat designs that had been proven efficient and safe (not to mention beautiful and much loved) since they were first designed in the 1800s. You know, "unsafe" old boats like Whitehalls, Wherries, Grand Banks dories, and such.

So, the original push to create TSCA was the preservation and celebration of historically "traditional" designs from a time before boats had motors. In the early days of the club, I think we mainly focused on those plank-on-frame designs, paying less attention to other small-boat options or construction methods, mainly because the newer types of small boats weren't being threatened by bumbling bureaucrats.

Today, happily, TSCA has evolved as small-craft designs have been realized in different materials and building methods. But the core passion for classic and "traditional" design remains: We celebrate small-boat enjoyment in more forms than we might have 40 years ago, while still appreciating the utterly classic lines and building methods of those timeless 1800s-inspired designs.

These days, home boatbuilding is dominated by stitch-and-glue plywood, kit boats, epoxy, and designs that seem loudly untraditional. Designers like Jim Michalak, John Welsford, Iain Oughtred, and the late Phil Bolger are responsible for more of

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Tennessee Skiff

by Jeff Robins

Slow, steady, and by the drop—the way a fine Tennessee whiskey is made and enjoyed. The same can be said about my boats.

The boats are built from memory, so I have the freedom to tweak the design depending on where each individual boat will call home. I first start by picking the Cypress for sides, which is a job in and of itself. I often go through many stacks of wood in order to find the few boards with just the right grain, knotting, and weight. Next comes planing the boards to the right thickness and squaring edges. The hardest part is convincing the cypress boards that they are not still trees standing in the southern swamps. But slow and steady pressure, with a little help from the Allman Brothers playing in the background, convinces the boards to bend.

I build from the center out and work my way to both ends simultaneously. The center sections of the boats can be designed a couple different ways: a sliding front seat, a casting seat, or a stationary seat. Over the years, I have widened the stern a little and deepened the seats. It seems that with time, the narrow stern gets a little tight for us older guys fighting gravity. The bow usually goes in with ease, but the stern is always a challenge, going from 40 inches wide to 9 inches wide in a 6-foot space can quickly lead to reaching my mental building capacity for the day.

I build rod holders into the center section and tackle boxes under the seats to keep a few essentials—lures, wallet, cell phone, and depending on where you are fishing, a pistol. The last place you want to be is floating down a river in the middle of nowhere, while the theme song of *Deliverance* plays, and not having a firearm handy.

The next steps involve adding a gunwale on the inside and out. I always like to use wood from interesting places for the spacers in the gunwale. Often time I will add a piece of wood from my granddad's country store as a spacer in the stern. Then, at the bow, I always like to add a piece of Jack Daniel's barrel wood. Years ago, my son and I built a guitar out of a Jack Daniel's barrel. It turned out so nice that I sent a picture of it to the distillery in Lynchburg and, to my amazement, I got a call from Jimmy Bedford a few days later. Jimmy invited us up to the distillery and I never will forget how he welcomed us like old friends and how he took the time to make us feel special; he was a true Tennessee Gentleman.

Fitting the bottom of the boat can be a challenge depending on how deep the rocker is. I first scarf the plywood together and then dry fit it to the bottom. Waterproof glue and 185 brass screws hold it all together. After the bottom is fitted, sandpaper becomes my best friend.

Once everything is fitted, sanded, and sanded once more, a coat of epoxy resin is applied inside and out. That dries for a few days, then it's time to sand some more. The last step is to add several coats of a clear satin spar varnish to protect the epoxy from UV rays. The majority of my boats are a natural finish to

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Applying Simplified Naval Architecture Principles to Designing and Modifying Traditional Boats

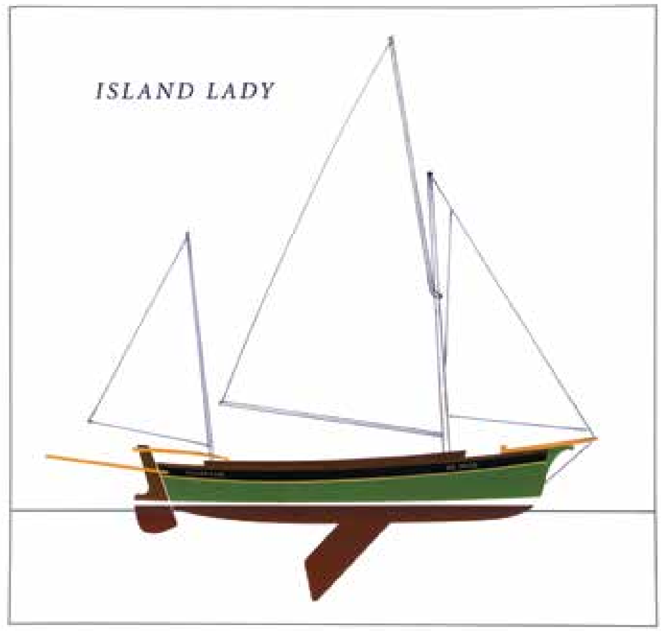
by David Wyman with photographs by Rosemary Wyman

One of the joys of messing about with traditional boats is not only using them but also designing, building, and modifying them to meet your individual needs and desires. Whether you want to start with an idea of a basic type of boat and a clean sheet of paper to design a new boat or just make a few modifications to an existing boat so it will better suit you needs, or somewhere in between, understanding and applying the basic principles of naval architecture to your work will likely result in a much better boat.

For simplicity I have broken boat design into four basic principles. A boat should:

Float – The boat must float both at a desired waterline when in use and, in the event of a capsize, float with adequate freeboard so that you can self-rescue. Making a boat float requires a balance of buoyancy and weight

Float Upright – The boat needs adequate stability both in use and in the event of a capsize



Move Through the Water – Propulsion, regardless of whether by oar, sail, or power, should be matched to the boat and its intended purpose.

Be Seaworthy – There are many aspects to seaworthiness. Adequate freeboard and proper outfitting are but two of the important criteria.

Pictured here are three boats to illustrate various degrees of design possibilities. The first shows a totally new design. The second shows a boat designed using an existing hull. The third is a boat slightly modified for better sailing. All the boats in this article were designed and are owned by the author, a practicing naval architect and marine surveyor who has designed a wide variety of boats, both for himself and for others.

Island Lady (above) – 19' canoe yawl, which the author designed and helped build. The objective was to create a boat small enough for day trips and large enough for limited cruising. *Island Lady* was designed with the canoe yawls of a century ago and also the Herreshoff 12½ in mind, but she is significantly different from both. She draws only 8" for beach cruising with centerboard and rudder up. She has a yawl rig; for auxiliary propulsion she has two sets of oars and an electric thruster built into her rudder.

Yankee Lady (left) – 12' peapod built from a purchased fiberglass canoe hull that was finished as a small rowing peapod. The fiberglass canoe hull is 12 feet long but has a beam 42 inches, which in my opinion, is much too wide

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Sizing Marine Wire—One Size Does Not Fit All

by Edward Scott, Bayside Marine Design

This is Part Two of a four-part article covering marine wire and electrical systems for small boats. The first part covered the wire itself; this part is going to show you how to determine the proper size wire (gauge) to operate your electrical equipment on your boat so that the wiring is safe and delivers the proper amount of voltage to each electrical device on your boat. This is by far the most important part of this article series. Determining the proper wire size in addition to proper fusing is what keeps your wiring system from starting a fire on your boat. There is minimal mathematics required to make this determination as long as your boat is less than 30 feet in length. This article will make use of tables that will keep you from having to overwork your calculator.

It has been already said in Part One of this series and in the introduction paragraph of this article as to the reasons for properly sizing the wire in your boat's electrical system. But to review, the most important reason is FIRE. This cannot be overemphasized enough. Wire that is carrying more current than it can handle WILL OVERHEAT, melt wire insulation, and start a FIRE. A fire in a boat is a deadly occurrence, particularly in a gas powered boat. The second reason is voltage loss. It is not as dramatic as fire but important none the less. Most small boats use 12 volt DC power for starting engines and running all of the electrical and electronic equipment on the boat. In order for this equipment to operate to specification, the voltage being supplied by the wire to the device must be 12 volts DC or within some small percentage of 12 volts. If the voltage delivered to the device(s) is too much less than 12 VDC, your navigation lights may not operate properly or may not operate at all. Navigation lights need to be a certain brightness. If the voltage is too low feeding the navigation lights, then they will not be bright enough, which may make your boat less visible in the dark or fog and also makes your navigation lights illegal. Another example is your marine radio. Your marine radio may not put out enough transmitter power with low voltage, which could keep you from getting necessary help in times of an emergency. So voltage level is very important, and the wrong wiring wire size could reduce the operating voltage of a device. What about too much voltage? Wire size never causes too much voltage. The only way for too much voltage in an electrical system is where the engine alternator is charging batteries, meaning the engine alternator voltage level is applied to your electrical system. This is controlled by a device called a voltage regulator. The regulator can fail in such a way that the voltage on your 12 VDC system can approach upwards to 50 VDC.

Some Easy Math

Remember from Part One, the relationship of wire length and wire diameter and the current level flowing in the wire? The longer the wire, the more resistance it has, which will lower the voltage fed to the device connected to that wire. In addition to length, another wire property that reduces voltage is the wire diameter. The smaller the diameter of the wire, the higher the resistance, which lowers the voltage to a device. How do we figure this out? Current flow through a wire obeys an electrical rule known as Ohm's Law. We will not require you to use this formula in everyday practice. It is shown here in hopes it will help you understand the relationship between all of the electrical factors involved in sizing marine wire. Ohm's Law is stated mathematically as follows: $I=E/R$ $R=E/I$ $E=IR$ where E=voltage, I=current, and R=resistance.

In a small boat E will always (not always but usually) be 12 Volts DC (direct current as from a battery). It will be the current (DC current measured in amps) that the electrical or electronic device will need to operate at 12 VDC. The device draws what it needs from the battery; every device has its own current requirement. R is resistance (measured in "ohms") of the wire and the wire only. Resistance is an electrical property of the wire that "resists" the flow of current in a circuit. So what does all of this mean? The battery supplies voltage (12 VDC); the device requires 12 VDC and draws a certain current from the battery. The wire connects the battery to the device, and in a perfect world, the wire would not have resistance; HOWEVER, wire has resistance, there is no way around it. Three factors affect the resistance of wire: its material, its diameter, and its length. For marine purposes, our material will always be copper and all of our calculations and tables will assume copper as the wire material. The second factor is its diameter, which is the wire gauge (diameter). The larger the diameter, the less resistance per foot the wire has. As the diameter is reduced, the resistance gets larger. For example, a 10 gauge wire has a larger diameter than a 16 gauge wire, giving the 16 gauge wire a higher resistance per foot than the 10 gauge wire. The third factor is the wire length. This is simply means "the longer the wire, the more resistance it will have." The only way to overcome the resistance due to length is increase the wire diameter (gauge). So our goal is to size the wire so its resistance is as close to zero as possible by balancing the diameter of the wire with its length with regards to the particular circuit the wire is used in. This means that for different devices and the different lengths of the wire to those

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Lost Coast Chapter Hosts Sea Scouts

Edited from emails and expanded by Andy Wolfe

The young crew of the Konocti Phoenix Sea Scout Ship was captivated by the stories and instruction of Dusty Dillion, TSCA Lost Coast Chapter, Fort Bragg, CA. Everyone had a wonderful day on the water, some learned something new, others relearned skills that do not get used often, and the adults just loved to see crew members enjoying themselves.

At one time, over a century ago, they were called Scouts of the Sea. The origins, like all of scouting, are British. The

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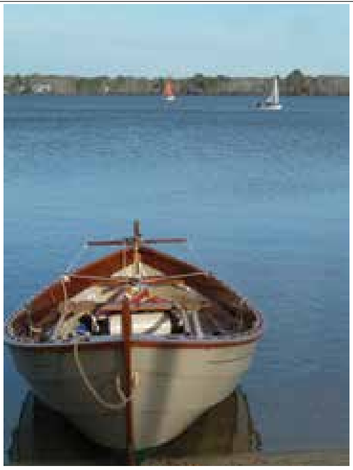
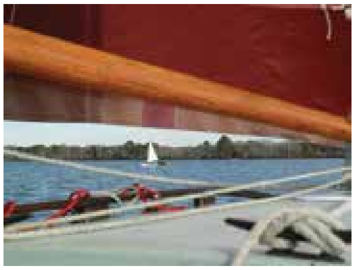


Cape Cod Chapter Row/Sail

by Bill Stirling

The Cape Cod Chapter had a late season outing on Sunday, November 15th at the Wequaquet Lake Yacht Club in Barnstable. The weather cooperated with a bright and sunny day of about 50 degrees. There was a small craft warning on Nantucket Sound but just a couple of miles inland we started off with wind gusts of 15–20 dropping to 10–12 out in the middle of the lake. After a great day on the water we were able to retire to the club and watch a close Patriots/Giants game, thanks to Don Stucke.



John Gardner Grant

In 1999, TSCA created the John Gardner Grant program to support projects for which sufficient funding would otherwise be unavailable. Eligible projects are those which research, document, preserve, and replicate traditional small craft, associated skills (including their construction and uses) and the skills of those who built and used them. Youth involvement is encouraged.

Proposals for projects ranging from $200 to $2000 are invited for consideration. Grants are awarded competitively and reviewed semiannually by the John Gardner Memorial Fund Committee of TSCA, typically in May and October. The source of funding is the John Gardner Memorial Endowment Fund. Funding availability is determined annually.

Eligible applicants include anyone who can demonstrate serious interest in, and knowledge of, traditional small craft. Affiliation with a museum or academic organization is not required. Projects must have tangible, enduring results which are published, exhibited, or otherwise made available to the interested public. **Projects must be reported in *The Ash Breeze.***

Program details, applications, and additional information:
www.tsca.net/JohnGardnerGrant.html

"To preserve, continue, and expand the achievements, vision and goals of John Gardner by enriching and disseminating our traditional small craft heritage."

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Boat Design

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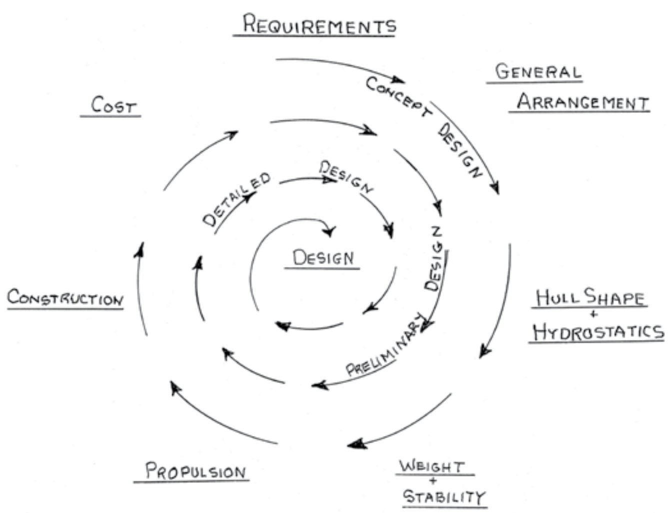
for a good canoe. Redesigned, she has become a great little rowing boat with a weight of approximately 60 pounds. The completion work was relatively simple so that she could be operational after only a few days of work at the beginning of my two-week vacation many years ago.

Sweet Pea (right) – 13' Doug Hylan designed and Carpenter's Boat Shop built peapod. This is a beautifully designed boat and I would not change a thing about the basic design of the boat. However, adding side benches, a rudder, belaying pins, and wood blocks have personalized her for me and made her more comfortable to sail.

To begin the design process, it is best to delineate a clear set of objectives for the boat. Objectives become obvious when you ask yourself the question "How will the boat be used?" These objectives in turn can be developed into a set of requirements for the boat—decisions about dimensions, speed, propulsion, etc. Next, the design is further developed by systematically utilizing a design spiral (below), which addresses all of the naval architectural issues. Proceed around the design spiral as many times as necessary to meet the aforementioned four



Design Spiral

principles of naval architecture. Doing this, you will be able to refine the design into a boat that satisfies the requirements and makes you happy.

In future articles (over the next several issues), I will address each of these principles separately in a way that should be relatively easy to understand and utilize. A sample design will be provided to explain and illustrate the design process.

President's Message

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today's new construction than Herreshoff, John Gardner, or others thought to be traditionalists. If you look at the designs of Welsford and Oughtred, you mainly see beautiful lines rooted in traditional, proven small-craft principles. But here's the surprise: Even with Michalak and Bolger, best known for boxy character-boat designs, you'll find some historically significant references, such as Michalak's graceful, double-ended *NH17* rowing boat, inspired directly by a Nathaniel Herreshoff pulling boat; or the Bolger 15' 6" Light Dory that Phil always said would be his ticket to heaven. (Nothing more traditional than a dory design, although Bolger's graceful Light Dory represented a breakthrough in featherweight construction.)

Trimarans are thought of as modern contraptions, but of course they were used more than a thousand years ago (along with proas and catamarans) to efficiently carry Polynesian explorers to new lands. So, while a Hobie Adventure Island trimaran might seem entirely too modern for most TSCA members, we have one in the front yard alongside our 1888-design 13' canoe yawl and thoroughly enjoy sailing both of them, for different reasons. Traditional lapstrake next to polystyrene—both beautifully designed and engineered, and in our minds both representing the evolution of what we consider "traditional."

Some folks are repulsed when associating any modern building material or method with "traditional," but go for a row in one of Adirondack Guideboat Company's Kevlar guideboat models and tell me it isn't a "classic" design? (Okay, their strip-built wooden guideboats are prettier and more elegant, but the lightweight, strong, fast, and functional Kevlar model makes more sense to many small-boat lovers who view their boat in much the way someone rowing a working Whitehall in 1880 might have looked at their hull—as a functionally perfect tool for work or pleasure, not as a floating Stradivarius to be kept under glass and hailed as the only boat accepted as "traditional.")

In fact, while many of us might have personal impressions of what TSCA considers "traditional," the organization itself has never defined "traditional" or even "small" with narrow precision...and that's a good thing. The main focus of most members, I think, is on the *smiles-per-mile* of small craft that are classic in their eyes, small in their view, and traditional to their personal sense of tradition. So, it's all good when you're on the water in a small boat—whether it's a stitch-and-glue skiff, strip-planked and epoxied canoe, or plank-on-frame Whitehall—as long as the boat's fundamental design harkens back somehow to smaller boats that were rowed, paddled, or sailed before engines started to replace sails and oars.

As members of TSCA, we're all free to define "traditional" and "small" in personal ways—and while rowing, paddling, and sailing are the main focus, no membership cards will be seized when folks add a small kicker motor to the transom of their camp-cruising sailboat. Small boats are about freedom, and that includes freedom to express our own sense of tradition.

Sail on...

–Marty

Tennessee Skiff

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show off Mother Nature's beautiful work. Occasionally, I will have some misguided soul ask me to paint one. I will paint it, but neither the boat nor I will be very happy about.

At the end of day, our life is a story—make yours a good one. I like to think that boats and a fine Tennessee whiskey are created the same way—slow and steady. And they should be enjoyed the same way—slow, steady, and by the drop.

Sea Scouts

continued from page 7

name evolved to Sea Scouts as seamanship was assimilated into the Boy Scouts Association back in 1912. Today there are 15,000 youth involved in co-educational Venturing Sea Scout programs in the United States.

The Kelseyville, California, Konocti Phoenix Sea Scout Ship 711 was founded twenty years ago. The program teaches young adults to develop competence and confidence on any body of water, teamwork, discipline, and leadership.

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Eye Candy

by Andy Wolfe

Rosemary Wyman is an award-winning professional photographer and photographic artist. For many years now, the covers of the *Ash Breeze* have featured her photography (even this issue). While not every issue features one of her photos, her cover images are highly complimented. For Rosemary, making an image is an opportunity to quiet herself and focus on the immediate present. It's a very special moment of interaction with her surroundings—when her unique images are born.

In recent years Rosemary has turned her artistic vision toward the world of small boats. Accompanying her husband, David, who is a naval architect, marine engineer, and small-boat

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Below: Rosemary Wyman receiving MPPA award.

Left: Award-winning photo "Oars Up."

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Top Right: Harrier, *designed by Tony Diaz, owned by Ben Fuller.*

Top Left: Washington County Peapod owned by Charlie Chamberlain.

Bottom Left: Gowan, *a rowing/sailing craft, Harry Bryan design, owned by Ray and Hildy Danforth.*

Bottom Right: Canvas canoe built and owned by Paul LaBrie.


GOWAN

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Chapter & Membership Notes

by John Weiss

While our boats may be "traditional," TSCA has entered the 21st century with a Facebook page at www.facebook.com/groups/TSCA.group/ and new membership fulfillment software. We have been sending preliminary renewal notices via e-mail for a year now. The better response we get from the e-mail notices, the more we save in postage, so PLEASE renew when you get your e-mail notice. We also tested the waters in our 2015 TSCA National Council election by conducting the election totally via the Internet (i.e., a link from our Facebook page) and e-mail. The test was a resounding success, with the largest turnout we've had in over 15 years. We expect that all future elections and membership ballots will be held electronically. So, PLEASE ensure we have your current e-mail address. Write it on your renewal form, enter it in the chapter/member# box on our PayPal renewal form, or send it to me at Membership.TSCA@gmail.com.

For those who may not closely follow the listings on the Chapter page, please alert your friends to several new chapters around the country in the past year: The Brooklyn Chapter is our 5th active New York chapter, working with the Sebago Canoe Club. The Cape Cod Chapter is now active after a long organizing effort. The Les Cheneaux Chapter is our third Michigan chapter, centered around the Sault Ste. Marie area. The Ralph Middleton Munroe Chapter is working with the Barnacle Society in Miami, and is our 4th in Florida. The Old Bay Chapter organized in the Richmond area, and is looking for more Chesapeake Bay boaters. And the Raleigh Chapter is our second in North Carolina.

We now offer hull insurance for chapter-owned boats.

For those chapters that have chapter-owned boats, hull insurance is available as a rider on the TSCA insurance policy. As an example, the Lost Coast Chapter pays about $240/year to insure their Monomoy Whaler for $20,000. Call me at 425-361-7758 for further info.

Personally-owned boats cannot be insured through TSCA, but you can take advantage of the low BoatUS insurance rates AND a 50% savings in annual BoatUS membership fees by citing our BoatUS Affiliated Group number GA84393B when you join or renew.

Marine Wire

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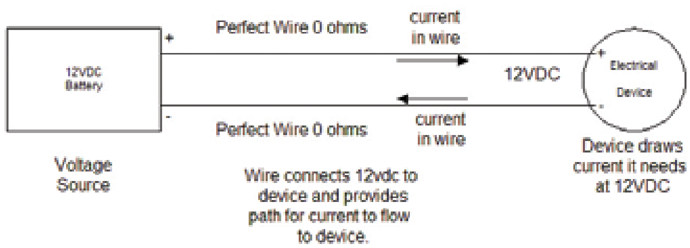
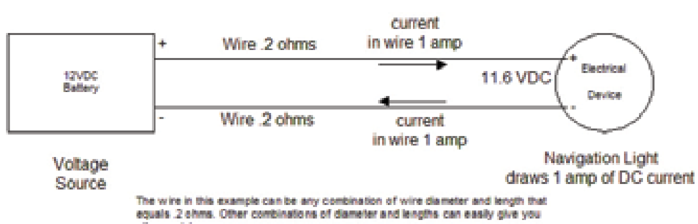
different devices, your wire size (gauge) may be different for each device. How do we determine this? By applying Ohms Law. Out of the three formulas mentioned above the one that will be of the most interest to us here will be: E=IR. You have to think of the wire as a component, just as the battery and your electrical device are components. Your battery supplies 12 VDC; your device needs a 12 volt level at its terminals, which means the wire can have no voltage across it from one end to the other (voltage drop). This perfect wire would have zero resistance. See the basic circuit below:



Basic Circuit

With perfect wire, there is no resistance therefore no voltage is lost across the wire, meaning all battery voltage goes to the devices. BUT, wire is not perfect. It has resistance. Copper is one of the lowest resistance materials that is REASONABLY priced. Gold is the best with silver coming in second place as far as resistance is concerned. But even those expensive metals have resistance. For our work, we must work around the resistance of copper wire. The formula (E=IR) states that the voltage across the wire is determined by multiplying the current drawn by the device by the resistance of the length of wire involved. Whatever the voltage is from this calculation, it is subtracted from the battery voltage and the remainder is what is available to the device. This means that if the diameter of the wire is too small for the required length of the wire needed between the battery and device, then too much voltage is lost across the wire, reducing the voltage available to the device, therefore not allowing the device to function properly. Study the following example to see how wire resistance lowers voltage to electrical devices.



In the circuit shown here, the battery is 12 VDC. The device requires 12 VDC to operate correctly. The device shown here also draws 1 amp from the battery during normal operation. The wire shown is a length and diameter that has a resistance of .2 ohms. Since the positive wire and the negative wire are both the same length, as they should be in a proper set-up, each wire contributes .2 ohms to the wire resistance giving a total wire resistance of .4 ohms. Now applying the formula E=IR, we have E=1 amp x .4 ohms which equals .4 VDC across the wires (.2 volts across each wire). Subtract .4 VDC from 12 VDC and you get 11.6 VDC at the terminals of the device. This is approximately 3.2% lower than 12 VDC (it is okay to round to 3%).

Most quality marine electrical equipment will operate properly with a 3% tolerance, above or below 12 VDC. Many devices will work fine with a 10% tolerance. The American Yacht and Boat Council (ABYC), who have written the electrical standards for the marine world, have specified 3% and 10% as the tolerance standards by which to design your wiring system.

Which Tolerance Level Should I use?

The choice of tolerance level has to do with a couple of factors. First and foremost, the voltage specification of the electrical device you are powering. This is determined by looking at the device's data sheet. Most equipment will list a voltage specification. However, marine lighting may not list a specification. It is up to you to know that applying 15 or more volts to their lights will probably burn them out pretty quickly. We will learn how to figure out current for lights in Part Four of this article series. Low voltage will not burn out a light, but it may not be bright enough to give you the illumination you want. This is extremely important with navigation lights. They need to be as close to 12 volts as possible as the illumination is directly related to the applied voltage. All navigation lights must be wired with a 3% or better voltage tolerance. All pumps and motor devices should be wired to 3%. Horns can be 10%, as can most convenience lighting. Marine electronics should be 3%, but a check of the data sheet will tell you what the manufacturer wants. This is important for marine radios and radar sets. If in doubt, wire everything to 3%. Now be aware that wiring everything to 3% can cost you more money, because wiring to 3% means you may have to use larger gauge wire for 3% to ALL devices when you could use smaller and therefore cheaper wire for devices that only need 10%. But unless you are building multiple boats in a production environment, the extra cost of keeping everything at 3% is not that much for one boat, but at least you know that your voltage tolerances are right on for everything in your boat.

Determining the Required Wire Size for the Tolerance You Need

To determine the wire size you need for your device or devices, you first need to determine what tolerances you need for your equipment. Once your tolerance level is determined, you can do one of two things. You could calculate the wire sizes from wire resistivity tables and applying the Ohm's Law formulas with wire diameter tables showing gauge versus diameter, and calculate the wire size. While this is the most accurate, it is also very time consuming and prone to human error. But we do not need to do that here! We will use tables (Tables 1 and 2) for 3% and 10% tolerance levels that show the length of wire and current draw of your circuit (device). To use the tables, all you do is look up your length (round to next highest length if your exact length is not shown), choose your current level (again go to the next highest current if your current is not shown), then read your wire size where length and current intersect, and there you have it, the required wire size. No mathematics, no physics tables. It is that simple.

Is Voltage Tolerance All I Need To Worry About?

Now that you have an understanding of wire size versus voltage tolerance, there is another important factor to consider. That factor is the CURRENT CARRYING CAPABILITY of the wire. Once you have determined the wire length to your device and the required wire gauge to give your device power with the voltage tolerance it needs, you need to determine if that wire size will safely carry the current the device will draw from the battery. This is done by consulting a special table that lists wire sizes and their safe current carrying capability (Table 3). With this table, you simply look up the wire size you have determined you need and go down to the current carrying capability. If it is higher than your device or total circuit requirement, then your wire size is good. You are ready to wire. Take notice on Table 3 there are two areas current is specified: "Outside Engine Spaces" and "Inside Engine Spaces." Use the current levels in the table depending on where the wire will run. If it goes through the hot area to other parts of boat, use the "Inside Engine Space" current even though the wire may be mostly out of the engine space. You should see that the current levels in the "Inside Engine Space" are lower than the "Outside Engine Space." This is because there is already heat in the engine space, and it will take less current to heat the wire to melt the insulation. All wire used in an engine compartment should have an insulation rating equal to or better than engine space temperature. Avoid running wires through the engine compartment that have no use in the engine compartment. A good overall rating for wire insulation is 105°C. This rating for the average boat under 30 feet will work with all wiring needs without having to worry about Inside or Outside engine spaces. But you still have to watch current levels in engine spaces.

Putting It All Together

Now we are going to put some of this knowledge together. The following is an outline of what you should do to determine wire sizes for equipment on your boat.

Determine where you are going to install your equipment (batteries, devices, etc.).

Determine the lengths of the wire from your battery or fuse/circuit breaker panel. (More will be covered on this in Part 4 of this article.) It is important here to remember to MEASURE THE LENGTH OF THE ACTUAL PATH THE WIRE WILL BE RUN, NOT A STRAIGHTLINE path. Then double that number, because your device power wires will ALWAYS consist of TWO wires, a positive wire and a negative wire, and they will normally be run side-by-side to the device. Example: run = 14 feet, total wire length will be 28 feet. That is the number for the voltage tolerance tables.

Determine the required voltage tolerance needed for the wire run based on device requirements. Determine actual current requirements of the device by looking at specification sheet. Go to tolerance Tables, plug in required current and wire length, and determine the wire gauge.

Now go to your current carrying table and check to see that the wire can handle the current. If it can, you are done. It is rare that it doesn't. If for some reason it doesn't, increase the wire size until it does. Remember, the larger the wire in diameter (gauge) the lower the resistance, so it is okay to use wire sizes (gauge) larger than the tolerance tables tell you. Also the length has nothing to do with current carrying capability; it is strictly the diameter.

Table 1: Wire Sizes For 3% Voltage Drop for 12 VDC electrical systems

Length of wire from power source or fuse/breaker panel to device multiplied by 2 in feet											
	10	15	20	25	30	40	50	60	70	80	90
Circuit current in amps	Wire Size (gauge)										
5	18	16	14	12	12	10	10	10	8	8	8
10	14	12	10	10	10	8	6	6	6	6	4
15	12	10	10	8	8	6	6	6	4	4	2
20	10	10	8	6	6	6	4	4	2	2	2
25	10	8	6	6	6	4	4	2	2	2	1
30	10	8	6	6	4	4	2	2	1	1	0
40	8	6	6	4	4	2	2	1	0	0	00
50	6	6	4	4	2	2	1	0	00	00	000
60	6	4	4	2	2	1	0	00	000	000	0000
70	6	4	2	2	1	0	00	000	000	0000	0000
80	6	4	2	2	1	0	000	000	0000	0000	
90	4	2	2	1	0	00	000	0000			

Example: 6 amp current draw device that is 15 feet from power source will require a #10 wire. You use the 10 amp line for current and 30 feet length for your length (2 x 15) and read #10 where 5 amps and 20 feet intersect.

Marine Wire

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Table 2: Wire Size For 10% Voltage Drop for 12 VDC electrical systems

Length of wire from power source or fuse/breaker panel to device multiplied by 2 in feet											
	10	15	20	25	30	40	50	60	70	80	90
Circuit current in amps	Wire Size (gauge)										
5	18	18	18	18	18	16	16	14	14	14	12
10	18	18	16	16	14	14	12	12	10	10	10
15	18	16	14	14	12	12	10	10	8	8	8
20	16	14	14	12	12	10	10	8	8	8	6
25	16	14	12	12	10	10	8	8	6	6	6
30	14	12	12	10	10	8	8	6	6	6	6
40	14	12	10	10	8	8	6	6	6	4	4
50	12	10	10	8	8	6	6	4	4	4	2
60	12	10	8	8	6	6	4	4	2	2	2
70	10	8	8	6	6	6	4	2	2	2	2
80	10	8	8	6	6	4	4	2	2	2	1
90	10	8	6	6	6	4	2	2	2	1	1

Example: 2 amp current draw device that is 10 feet from power source will require a #18 wire. You use the 5 amp line for current and 20 feet length for your length (2 x 10) and read #18 where 5 amps and 20 feet intersect.

Table 3: Current Carrying Capability of Single Conductor Wire for 12 VDC Systems

Temperature Rating of Wire Insulation												
	60°C (140°F)		75°C (167°F)		80°C (176°F)		90°C (194°F)		105°C (221°F)		125°C (257°F)	
Wire Size	Outside Engine Spaces	Inside Engine Spaces	Outside Engine Spaces	Inside Engine Spaces	Outside Engine Spaces	Inside Engine Spaces	Outside Engine Spaces	Inside Engine Spaces	Outside Engine Spaces	Inside Engine Spaces	Outside Engine Spaces	Inside Engine Spaces
18	10		10	7.5	15	11.7	20	16.4	20	17	25	22.3
16	15		15	11.3	20	15.6	25	20.5	25	21.3	30	26.7
14	20		20	15	25	19.5	30	24.6	35	29.8	40	35.6
12	25		25	18.8	35	27.3	40	32.8	45	38.3	50	44.5
10	40		40	30	50	39	55	45.1	60	51	70	62.3
8	55		65	48.8	70	54.6	70	57.4	80	68	90	80.1
6	80		95	71.3	100	78	100	82	120	102	125	111.3
4	105		125	93.8	130	101.4	135	110.7	160	136	170	151.3
2	140		170	127.5	175	136.5	180	147.6	210	178.5	225	200.3
1	165		195	146.3	210	163.8	210	172.2	245	208.3	265	235.9
0	195	Not	230	172.5	245	191.1	245	200.9	285	242.3	305	271.5
00	225	Allowed	265	198.8	285	222.3	285	233.7	330	280.5	355	316
000	260		310	232.5	330	257.4	330	270.6	385	327.3	410	364.9
0000	300		360	270	385	300.3	385	315.7	445	378.3	475	422.8

Example: #12 wire with 105°C (221°F) temperature rating can carry 45 amps outside engine spaces and 38.3 amps in engine spaces.

These Tables are condensed for use in boats under 30 feet. For a complete set of wiring tables consult ABYC Standard E-11 .

In Summary

Part Two of this article contains the information that you must master in order to set-up a proper wiring system in terms of wire sizes. This will minimize the chance of fire as well as make sure your electrical devices have the voltage they require. The tables shown here will help you accomplish this without using the electrical formulas. Part 3 of this article will cover circuit protection, a vital component of fire safety in a boat's electrical installation. Part 4 will put all of the first three parts together and show you how to develop a safe and reliable wiring system for your boat project. Remember this article is for boats under 30 feet with simple electrical systems.

You can contact Ed at: ed@baysidemarinedesign.com

ABYC – American Yacht and Boat Council, www.abycinc.org, Standard E-11 can be purchased separately from other standards from ABYC.

Eye Candy

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enthusiast, to a wide variety of boating events has provided a rich source of material for her images. Rosemary's photographs have been exhibited both locally (in New England) and nationally. In addition to the *Ash Breeze*, her work has appeared in *WoodenBoat* magazine, and has been featured on the cover of *Mariner* magazine. Her book *We Build a Dory* documents a year-long boatbuilding project by 7^{th} and 8^{th} grade students at the Adams School in Castine, Maine.

Among the honors she has earned in her career as a professional photographer are the Kodak Gallery Award, the Fuji Masterpiece Award, and the coveted Wynn Tracy Memorial Award: Maine Photographer of the Year, which is presented by the Maine Professional Photographers Association. Rosemary owns and operates her photography business, Rosemary's Point of View, from her home in Castine, Maine.

So to keep everyone dreaming over the long winters, when some are building new boats, and others are repairing and restoring their boats, or still others, like me, are putting off seasonal maintenance in hopes of warmer weather…here are a few choice images to enjoy.

Right: Polaris, *dory designed by Clint Chase, built by Junior Craven, owned by Junior & Mary Craven.*

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The Ash Breeze

Spring 2016, Volume 37 Number 1

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