THE MARINE BATTERY GUIDE

HOW TO SELECT, INSTALL AND MAINTAIN YOUR BOAT'S BATTERIES

Ken MacKenzie Communications

Batteries are an expensive item aboard any vessel. Every effort should be made to sustain their lifespan and optimize performance.

Important Notice

This document contains general information regarding marine battery considerations. Contents herein do not constitute a warranty

Contents

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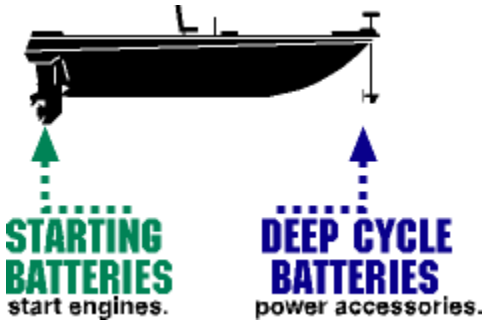
Chapter 1: Selecting the Right Marine Battery

Boat batteries, (or marine batteries), are crucial to the optimal operation of your boat. You need a reliable battery if out on the water and, the best marine battery for your boat depends on your needs and budget.

The battery system aboard a vessel provides the power for most of the onboard systems, including: lighting, bilge pumps, fresh water and waste water pumps, a wide array of navigation systems, anchor winch, entertainment systems and the engine starting system. An understanding of their selection, care and maintenance will protect your investment. Regular maintenance will also greatly improve their operational life span

How do you choose a marine battery that will meet your requirements and, power? It needn't be confusing if you're buying your first battery, this guide will break it down and you can be ready for your next voyage.



Marine batteries come in a wide selection; by looking at different attributes of a marine battery it will assist you to select the right battery for your vessel.

When choosing a marine battery it is critical to invest in a battery that has been designed and manufactured specifically to handle the extreme demands of marine environments and modern extensive electrical systems.

You need batteries that are equipped to handle the rigours of wave pounding, engine vibration and trailer transport while delivering reliable starting power and performance

First, decide what type of battery you want. To avoid becoming a maritime statistic, it is important to understand the power requirements to run on-board accessories and still have sufficient capacity to start the engine and get you home at the end of the day.

Perhaps it's shocking considering their retail prices, but most batteries sold through marine hardware stores do not qualify as premium batteries. Pay close attention to what you're buying. Batteries are not created equal and brand or prices are not the primary indicator for quality. Thus, Caveat Emptor! Try to get as much information about your prospective marine batteries before you buy or you'll be sorry.

Marine batteries are divided into starting batteries, deep cycle batteries and dual-purpose batteries.

Lead acid batteries:

These are by far the most common type of batteries used aboard boats today. Lead acid batteries contain lead plates with separators to differentiate the positive plates from the negative plates. The electrolyte is made up of 35 percent sulphuric acid and 65 percent pure water

They can be divided into two categories. These are deep cycle batteries and engine starting batteries.

Starting or Cranking Batteries:

These are intended to put out a large amount of current for a short period of time like you need when you're starting a marine engine. A starter battery, for instance, is a 12-volt battery that works to start your engine. These are also called cranking batteries. Their job is to start your main engine, using a lot of juice initially and then reducing the charge. Once the engine starts the onboard alternator quickly recharges the battery.

When a battery is called upon to deliver several hundred amps of current to the starting motor, the battery must be able to deliver this power quickly...within a few Seconds. This power comes off the surface of the plates inside the battery.

Therefore, a battery with more plate surface area and less resistance will deliver power quicker than one with less plate surface and high resistance. That's why starting batteries are made with thinner plates...because you only use the power off the surface of the plates for starting the engine. When the engine is running, the alternator quickly replenishes the battery.

These batteries do not lose water as rapidly as the deep cycle batteries. If starting batteries are subject to deep cycling, their performance will typically deteriorate rapidly.

The power level you need depends on the cranking requirements of your engine. Marine starting batteries are not designed to provide trolling or deep cycle power, which requires plates built to different specifications.

The marine cranking amp (MCA), or just cranking amp (CA), rating found on a battery's label measures a battery's starting power. And, if you're using a newer model outboard with sophisticated computers, pumps and sensors that don't take kindly to being underpowered, you certainly don't want to scrimp on starting power.

Check your engine's manual for its recommended MCA/CA rating before shopping for a battery and, always choose a battery with a rating equal to or greater than the recommended value.

Marine electrical experts recommend that boat owners have a dedicated starting battery for each engine. The starting battery should be independent of other systems requiring electricity.

The marine cranking amp (MCA) or cranking amp (CA) rating on the battery indicates its starting power. Your engine manual should tell you the recommended MCA/CA for your engine. Get a battery that meets or exceeds that rating.

Deep Cycle Batteries:

Your boat's house battery bank uses deep cycle batteries, the marathon runners of the storage system. They power the electrical loads on your boat when no charge source (shore power charger, engine alternator, wind generator or solar panel) is available. Consider them a kind of savings account into which energy is deposited or withdrawn.

A house battery or house battery bank supplies power to all the components and systems that run on Direct Current electricityon your boat. Deep-cycle batteries are used for house power. This type of battery is designed to supply a steady flow of power over a long period of time.

Compared to starting batteries, which deliver high bursts of energy for short periods, deep cycle batteries recover fully after being heavily discharged over longer periods because their design features thicker plates with a high content of antimony. Overnight, their use might deplete 50-70 percent of the battery capacity, depending on the house loads of the boat. When the batteries are recharged, energy is re-deposited into the bank, and the process, or cycle, starts over.

Generally, deep cycle batteries should be sized to store three to four times the expected amount of energy to be used between recharge cycles.

These put out a smaller amount of energy for a long period of time. A deep cycle marine battery is designed to power peripherals and, they consume power more slowly, allowing onboard electronics to run continually.

A deep cycle battery is called upon to deliver a long, slow discharge of fewer amps...for several minutes or hours...in a deep cycle application, such as running a trolling motor or heavy marine accessory load (e.g. depth finders, inverters, fish finders, radios, radar, lights, coolers, house power, etc.)

In this case, the power comes from deep within the plates, not merely off the surface as in a starting battery. Therefore, deep cycle batteries are specially engineered with heavier, thicker plates with fiberglass reinforcement, special power-producing active material and special heavy-duty separators.

With these features, the battery can withstand the potentially damaging effects of continual deep discharge and recharge. The un-reinforced, thinner plates of a starting battery cannot handle this constant deep cycling, and will fail quickly.

Water loss is a marked characteristic of these batteries; thus the water level should be checked regularly. Deep cycle batteries do not recover well if subjected to water loss for as deep cycle batteries incorporate thicker grids, denser active material on the plates and alloys specifically designed to provide many cycles.

They can be charged and recharged many times without damaging the internal components of the battery. These batteries have a lower MCA rating and higher reserve capacity/ amp hour rating than dual purpose or starting types. The only difference in these two types of batteries is how much power is delivered and how long it needs to be delivered.

Chapter 2: How your deep cycle batteries work:

A marine battery holds electricity for later use.

The marine battery develops voltage from the chemical reaction produced when two unlike materials, like the positive and negative plates, are immersed in the electrolyte, a solution of sulphuric acid and water.

In a typical lead acid battery, the voltage is approximately 2 volts per cell, for a total of 12 volts. As soon as there is a circuit between the positive and negative terminals, electricity flows from the battery. This happens when any load that needs electricity, such as your boat, is connected to the battery.

Most people don't realize that a lead acid battery operates in a constant process of charge and discharge. When marine deep cycle batteries are connected to a load that needs electricity current flows from the batteries. The marine batteries begin to be discharged.

In the reverse process, marine batteries become charged when current flows back into them, restoring the chemical difference between the plates.

When a marine battery discharges, the lead plates get more chemically alike, the acid becomes weaker, and the voltage drops. Eventually the battery is so discharged that it can no longer deliver electricity at a useful voltage.

By feeding electrical current back into it you can recharge a discharged battery. A full charge restores the chemical difference between the plates and leaves the lead acid battery ready to deliver its full power.

This unique process of discharge and charge in the lead acid battery means that energy can be discharged and restored over and over again. This is what's known as the cycling ability in a battery.

If the battery won't start your boat, you usually refer to it as "dead," even though that's not technically correct. A battery that's merely discharged can be recharged to its full capacity by using a marine battery charger. But a lead acid battery that's at the end of its service life can't be recharged enough to restore it to a useful power level. Then it truly is dead, and must be replaced.

A boat's lead acid battery is deep cycle:

Lead acid batteries are designed to be discharged down as much as 80%, time after time, and have much thicker plates. The major difference between a true deep cycle battery and others is that the plates are solid lead plates - not sponge. Often, it is impossible to tell what you are really buying in some discount stores or places that specialize in batteries. The popular marine battery is generally a "semi" deep cycle - better than any starting battery, better than most marine, but not as good as a true deep cycle, solid lead plate.

The purpose of a lead acid battery:

The purpose is to supply electricity for a given period of time before it needs to be recharged. This differs from one designed for engine starting. The deep cycle cannot supply high current demands but can supply lesser current for a longer period of time without damage.

The very nature of deep cycle batteries seems to invite misuse and damage. Operating for extended lengths of time at less than full charge with deeper discharges causes increased build up on the plates. This build up prevents electricity from flowing. The battery consists of lead plates in a solution of sulphuric acid. The sulphuric acid and the lead plates act together to store electricity.

However, this process creates a gradual build-up of a residue called lead sulphate (sulphate for short) on the plates. The sulphate build up reduces the flow of electricity because it prevents the acid from contacting the lead plates.

Therefore, deep cycle batteries require maintenance and you should recharge your marine batteries as soon as possible after each use and maintain the State of Charge at 100% to prevent permanent build-up.

As a general rule of thumb

If you use your boat for a long period of time, then charge the batteries when you're done. This is based on the system having an automatic charge control in the charger. In today's market it's hard to overcharge your batteries. However, if a defect occurs in the charger or battery itself, it's possible. To ensure that this doesn't happen it's recommended that you monitor your boat's charge time as well as regular maintenance on the system.

Dual-Purpose Batteries:

These are a kind of blend of the properties of the two. Ideally, you would have both a starting battery and a deep cycle marine battery on your boat.

It is generally advisable to use either a deep cycle or starting battery for best performance and battery life, but dual-purpose batteries work well in some applications.

Dual-purpose batteries are ideal for applications that require starting and deep cycle service. They deliver powerful cranking amperage for easy starting, and low amp draw service for reliable auxiliary power.

Since they have lower storage capacity than comparably sized deep cycles, we recommend them for the following applications:

- Runabouts or other small powerboats using a single battery for both starting and running loads with the engine turned off.
- Sailboats with two identical batteries used interchangeably for starting and house electrical loads.

- Boats with one battery bank that does double-duty for house applications and engine starting.

Dual-purpose batteries will last longer and give more reliable service than a starting battery, for about $20 more per battery.

In boats fitted with multiple accessories such as fridges and lighting systems, a dual battery system utilizing a secondary Deep Cycle battery is recommended.

Dual battery systems run a dedicated starting battery and a Deep Cycle battery in conjunction with each other. This allows the starting battery to be used for cranking the engine and then isolated when the engine is switched off. The Deep Cycle battery is then used to power accessories such as the lights, without compromising the performance of the starting battery.

Chapter 3: Which Battery Should You Choose?:

Ideally, you could have one battery for starting and an auxiliary deep cycle battery for the trolling motor and accessories. If however, you can only have one battery on board, the one you choose depends on the power draw required.

For light to moderate-duty low amp draw service, choose the dual-purpose battery, specially designed to handle both starting and cycling.

For heavy-duty cycling, choose the deep cycle battery. This will give you enough cranking amperage to start your engine, and the most reserve power to keep your trolling motor and accessories running longer.

Always be sure that the replacement battery CA and CCA meet minimum engine starting requirements.

You may want to consider maintenance free, sealed battery, either one of the AGM batteries or possibly one of the Gel batteries.

These batteries are completely sealed with pressure relief caps on top, so even if you turn them upside down, like if you were to capsize your boat; you're no going to spill our any electrolyte.

Batteries come in a variety of different sizes. Your boat may be designed to take a battery of a very specific size, but frequently you can actually get a larger battery by changing the battery box just using more of the space available.

So, whenever you're replacing a battery think about upgrading to a larger size if you have room.

Many boats are underpowered, but this is easy enough to remedy with the right marine battery. Most manufacturers have a complete line of batteries for all marine applications. From personal watercraft to mega yachts.

How to figure out how much power your boat consumes daily on average:

List the appliances you want to power, as well as the amp draw of each (you can figure this out by dividing watts by volts). Next, determine how long you use each appliance in an average 24-hour period. Say you come up with a power consumption of 100 Ah (amp/hour).

Getting a 100-amp battery is not good, though, because the capacity is measured by the intervals between charges. With 100 Ah, you would have no reserve. Typically, you want about four times your average consumption, so a 400 Ah battery will be best. One more note: if you keep your battery charged up to about 50 percent capacity, you can extend its life dramatically.

Since marine batteries lead a pretty tough life you may want to select a battery that has a longer warranty period. Battery warranties vary from about 18 months to 5 years. It may be worth your while to consider a battery that has a longer warranty.

If you find you're replacing your batteries more frequently than you should be you might want to have a marine electrician, or possibly a boatyard, look at your electrical system to make sure its charging your batteries correctly.

Unlike car batteries, which generally travel on smooth, sealed roads, marine batteries must be able to resist vibration from wave pounding and trailer transport. Repeated vibration and wave impact on non-marine batteries can cause damage and cracks to appear in the battery's internal components and outer case. This can cause shedding of active materials, accelerate corrosion, cause electrolyte leaks to occur and ultimately lead to battery failure.

When choosing a marine battery it is critical to invest in a battery that has been designed and manufactured specifically to handle the extreme demands of marine environments and modern extensive electrical systems.

Marine batteries must not only have the starting power to crank over high compression engines but also provide the reserve capacity needed to run on board accessories.

Buyer's Guide to Marine Batteries
https://www.youtube.com/watch?v=_W90MLv7_G4

Tips on choosing the right marine batteries

As a boat user you want your boat to be reliable as any unexpected downtime may cost you both money and your enjoyment. What could be worse than having your boat's batteries go dead while on the water?

Boats use a bank of standard **lead-acid batteries** to run an electric motor. They are designed to be used all day then recharged all night.

Choosing the right battery and knowing how to properly maintain your boat are two of the easiest, yet overlooked, ways of ensuring the operation of your vessel.

The freshness of a new marine battery is very important. The longer a marine battery sits and is not recharged the more damaging sulfation build up there may be on the plates.

Check the date code on the battery to make sure it hasn't' been sitting on the shelf for ages. This can seriously affect performance. Most marine batteries have a date of manufacture code on them. Letters and, the year by numbers indicate the month. For example, "D2" denotes a battery manufactured in April 2012. Always buy the freshest one on the shelf.

Upfront costs are what most people usually look at. However, marine batteries are the component that are most often skimped on, but can make or break your enjoyment of the water. Price is a fair indicator of the overall expected life of your batteries and is most likely the most important aspect of the purchase, as you will depend on the strength of the marine batteries power to keep going for long durations. As a general rule, the more expensive the marine battery, the longer it will last. Generic marine batteries can be expected to last 3 to 5 years

To obtain the best return on your battery investment, follow the guidelines outlined in this ebook to obtain the maximum performance and life from your deep cycle batteries.

When you buy your marine batteries, make sure that they come with a warranty, so that you can be confident it will be replaced if it fails sooner than could be reasonably expected. Marine batteries are expensive, and the assurance of a warranty will give you peace of mind that you are getting a good, quality product for your money.

The Capacity is important:

The next thing for you to consider is the capacity, which is rated in minutes or ampere hours (AH).

It works this way. The more you use your boat the more capacity you'll need.

For example, you could use the capacity the boat manufacturer uses as a baseline. However, if you want to use your boat more then you may need a higher capacity battery. Then again, if you need less, you may be able to get away with a lower capacity battery.

Therefore, when choosing the right battery, you should lean towards the safe side and oversize a battery for capacity. Undersizing a battery may leave you stranded, while oversizing will simply give you longer life

What voltage is my boat?

Determining how many volts your boat uses is as easy as counting the water fill caps on the batteries. The water fill caps are located on each battery. Each battery cell covered by a cap is 2-volts. Simply count all of the battery fill caps on your batteries, multiply this total by two, and you will have determined your boat's voltage.

A 6V battery has three water filler caps.
An 8V battery has four water filler caps.
A 12V battery has six water filler caps.

Even the sealed batteries have cells and each cell is 2 volts but these are usually harder to identify in this manner. The advantage here is the sealed battery is usually cleaner so the label stays intact.

Marine batteries are connected in long series string. It is very important to have balance so all of your batteries should have the same voltage to ensure you don't damage your batteries.

There are other battery types that are also used by boats, which include 12 volt, 24 volt, 36 volt and 48 volt but remember that you need to run your batteries in series.

It's always best to have a professional install your batteries correctly. A technician knows and understands how your batteries need to be hooked up.

While reading this ebook, please keep in mind that all battery systems are unique. Battery type, charger technology, equipment loads, cable size, climate, and other factors can all vary. Slight or significant, these differences will require battery maintenance to be adjusted. Therefore, use this ebook only as a guideline for proper battery care. Each particular system will always require a degree of customized attention.

Chapter 4: Understanding Battery Ratings:

Batteries are rated using the standard BCI (Battery Council International) industry ratings. These ratings are designed to help you select the proper battery for your boat. In order to determine which battery is right for a specific application, you should understand the following ratings.

The Amp Hour (AH) specification provides a measurement of battery capacity. In other words, it is an indication of how much energy can be stored by the battery.

Starting functions: the amount of power available for cranking a starter is measured several ways.

CCA vs. MCA: the two common power measurements are CCA (Cold Cranking Amps, the number of amps a battery can deliver for 30 seconds at 0°F while maintaining its voltage above 7.2 volts) **and** MCA (Marine Cranking Amps, similar but measured at 32°F instead of 0°F). The reason that MCA are 20-25% higher than the CCA is because batteries work better at higher temperatures.

Battery Size: engine size, type, and ambient temperature determine what size cranking battery you need. High cranking power (and a larger battery) is required for cold temperatures, diesel engines, or large and high compression gas engines.

The first sizing criteria is to meet the minimum CCA (if any) stated by the engine or boat manufacturer.

Deep cycle functions: battery capacity measurements are commonly expressed in Amp-hours (Ah) and Reserve Minutes. Amp-hours measure the total amount of power that a single battery can deliver for 20 hours at a constant rate of discharge, before the voltage drops to 10.5 volts.

This means that a 200Ah battery can run a 10A load for 20 hours. The reserve minute rating is the number of minutes that a battery can run a 25A load until dropping to 10.5V, just like with starting batteries. A Group 27 deep cycle battery with a rating of 180 reserve minutes will run a 25A load for three hours. House loads range from 5A to 25A or more. Ah is generally the more relevant measurement for house banks.

Longevity: battery manufacturers measure longevity by discharging full batteries at a temperature of 80°F until their voltage drops to 10.5 volts. The batteries are recharged under controlled conditions, and the process is repeated until the battery fails to hold half of its rated capacity. This measurement, called cycle life, shows how many discharge cycles a battery provides over its lifespan. This ability to cycle repeatedly is what differentiates deep cycle batteries from starting batteries, which can't withstand more than a few deep discharges before they begin to fail. If nothing else, cycle life provides a baseline for comparing one battery to another.

Ampere Hour Rating (Reference Rating)

This is the number of amps, which a battery can deliver for a 20-hour period. This test is also referred to as the 20-hour rate. The higher the ampere-hour rating, the more power the battery can deliver over time.

The 20 hour rating is the capacity of the battery determined over 20 hours at 80° F (26.7°C). A battery rated at 100 A.H. for 20 hours means that if you divide 20 into 100 the battery can be discharged at 5 amperes continuously for 20 hours. Likewise, if the rating was at 8 hours then divide 8 into 100. This would mean that the battery could discharge 12.5 amperes for 8 hours.

Marine batteries are usually rated at the 20 hour or 8 hour rating. The 8-hour rating is usually approximately 82% of the 20-hour rating.

Marine Cranking Amps (MCA)

This is the number of amps a battery can deliver at 32 degrees Fahrenheit for 30 seconds, and maintain at least a voltage of 1.2 volts per cell. This differs from cold cranking amps which are measured at 0 degrees Fahrenheit. The cranking performance is a measure of the maximum load a battery can withstand for 30 seconds at 0° F or 17.8°C. The cut off voltage is 7.2 volts for a 12-volt battery. The cranking performance of a battery is determined by the square inches of surface area of the positive plates

Reserve Capacity (RC)

This is the time, in minutes, for which a battery will deliver 25 amperes at 80 degrees Fahrenheit. This represents the time which the battery will continue to operate essential accessories in the event of alternator or generator failure or while the key is off.

The reserve capacity is defined as the number of minutes a battery can be discharged at 25 amperes. The temperature again is 80°F or 26.7°C.

The 20 hour, 8 hour and reserve capacity of a battery are determined by the volume of active material. To obtain the maximum in these ratings the battery would be designed with fewer, but much heavier plates.

R.C. minutes can help you predict how long you can run a trolling motor off the battery. A good standard is a 40lb thrust trolling motor on full speed draws about 42 amps continuously.

When comparing batteries ask about the ratings, as this will determine the physical size of a battery you will need. But do not stop, ask additional questions.

It is most important that you know the type of insulation. Cellulose (impregnated paper) is the least desirable. Ask about the thickness of the glass mat. It should be nothing less than 0.020. Ask about plate thickness and height. The weight of the battery is a good guide as to the thickness and height of the plates. A thin plate battery will weigh less. If your dealer is knowledgeable and is not trying to confuse you, he will have the facts.

Chapter 5: Determining The Energy Use of Your Boat: Ampere Hour Draw:

There are more factors to consider when choosing a marine battery. You should determine the size and/or the number of batteries for your house power. This depends a great deal on the amount of electricity the systems on your boat will likely consume over a given period of time.

Figuring out the planned amount of energy use requires some math. Energy use is measured in amp hours. How much electricity will your DC loads use? The current, or amps, multiplied by the time of operation, or hours, equates to amp-hours (Ah) per day. For example, if you have two running lights that each draw 1.5 amps, and those lights are operating for five hours a night, the Ah per day consumption would be 2 x 1.5 x 5 = 15 Ah/Day.

A small powerboat, usually rigged without a separate generator, generally consumes from 60 to 200 Ah per day. A large cruiser or sportfisherman could easily consume upwards of 400 Ah per day.

To calculate what your boat needs make a chart and list the consumption amounts of all systems, everything from the head, to the bilge pump, to the GPS unit. Now, if your boat has AC power, too, that must be factored in if an inverter is used aboard to turn AC current into DC current. More math is required to translate AC usage into DC usage. AC watts x hours/10 = Ah/Day. Now add all of the consumption figures up to come away with a gross energy consumption Ah/Day.

With this figured out, you can determine the battery capacity that meets your energy needs and begin the process of choosing a marine battery. Many experts say your battery capacity should be three to four times your daily energy consumption. So a boater using an estimated 160 Ah per day should have a house battery bank capacity of 560 Ah of capacity.

In order to determine the ampere-hour draw of your vessel, you need to know what electrical equipment you have and what the 12-volt amp draw is. The following table is a listing of typical 12-volt equipment aboard most boats and the average amp draw per hour.

The subject of boat electrics is a complex one, but the bottom line is that the current draw, battery bank capacity and charging regime must all be matched for the 12volt system to function satisfactorily.

Here we deal with the first part of that equation; calculating the current draw of your domestic circuit of the boat electrics over a typical 24 hour period.

Once this is known it's straightforward to assess the required size of the domestic battery bank.

The first step is to calculate how many amps you use daily. To do this, you must go through meticulously and calculate amp usage by hours used by anything aboard.

If you don't know how to calculate amp usage for each individual thing that uses electricity, you're going to have to be a bit of a sleuth – you need to find the watts and voltage for each light bulb, each appliance and so on. Most packaging will contain the information you need, often you can look it up online.

And with that knowledge we can readily calculate the battery charging regime necessary to prevent undue strain on the batteries and keep the whole electrical system ticking over.

In order to determine the proper amp hour rating capacity you need for your boat, simply add up the 12-volt accessories you have, multiply by 20; that should give you a very good approximation of your boat's amp hour battery requirement.

It is usually advised to buy a battery at least 20% over this requirement, as 12-volt capacity varies with usage and as batteries age. However, many experts say your battery capacity should be three to four times your daily energy consumption

Ratings can usually be found on equipment nameplates or in their manuals, and will be expressed in terms of power (measured in watts) or current draw (measured in amps). The relationship between power and current is expressed as:

Power (W) = Current (A) x System Voltage (V)

To derive amps from watts, simply transpose this equation and divide the wattage by the system voltage.

For example, a 6 watt navigation light bulb in a 12 volt system will draw 0.5 amps - which, if it's switched for ten hour each day when underway will have consumed 5 amp/hours (Ah).

Each item of equipment will produce a table much like that following.

12-VOLT ITEM	AMP DRAW
Bilge Pump (500 gph)	2.0
Bilge Pump (1000 gph)	2.9
Bilge Pump (1500 gph)	4.9
Bilge Pump (2000 gph)	8.4
Navigation Lights	1.5
Live well pump	7.0
Fresh water pump	4.0
Refrigerator (12 volt)	6.0
Ice Maker	6.0
Macerator	9.0
Anchor Windlass (900 lb)	75
12 Volt House Lighting	0.15 per 10 watts
Spot Lights (100k cp)	6.0
Spreader Lights (3K cp)	3.0
Radar (24 Mile)	5.0
GPS	0.8
Loran	0.7
VHF Radio-Transmit	6.0
VHF Radio- Receive	0.5
Fish Finder- (LCD)	1.0
Depth Finder- (Color)	3.0
SSB - Transmit	3.0
INVERTERS*	
SSB - Receive	2.5
Autopilot	5.0
Stereo (50 Watt)	0.5
Fan	1.0
TROLLING MOTORS	
24 lb Thrust	27
30 lb Thrust	30
36 lb Thrust	36
42 lb Thrust	40
45 lb Thrust	55

*** Inverters vary on 12-volt amp draw depending on 115 volts A/C draw. Please consult your inverter manufacturer for additional information.**

The above calculations though, remain estimates.

For example:

- In cold weather the fridge will draw less power than in hot weather.

- In rough weather the autopilot would use more power than when it's calm.

Hours of darkness will vary with latitude and time of year, affecting current draw for navigation and domestic lighting.

- You'll use the water maker more when you've got guests aboard etc, etc

Plus there are start-up currents and other losses that have been ignored.

- Additionally, the above amp draw is for "on time" while the batteries are being used. Remember, a refrigerator, fresh water pump, and macerator, etc. only draw power intermittently.

So what's the difference between amps (A) and amp-hours (Ah)?

One is current and the other is power.

The best way to explain it is by example...

If an appliance drawing 5A was to run for 1 hour, its consumption would amount to 5Ah. This would be the same as an appliance drawing 1A running for 5 hours - again the consumption would be 5Ah. So amp-hours are

Chapter 6: Inverters

Adding a new level of enjoyment to your boat:

By supplying 120 Volt AC power, inverters allow you to use things like TVs, other home entertainment equipment, computers, printers, microwaves, and power tools when far from shore power and without using a generator. They can also recharge dead cell phones or hand-held VHF batteries with AC chargers.

Choosing the right size inverter depends on many factors, but it's generally better to obtain one too big than "just right" or too small.

120 Volt AC power on board usually comes from three sources: shore power, a generator, or an inverter. Assuming you don't wish to stay tethered to the dock, your choice between a generator or an inverter depends on your power requirements underway. Typically today, many boaters have both a generator and inverter aboard. They complement one another nicely.

Inverters have a variety of advantages. They are an economical, maintenance-free, and relatively compact source of AC power.

What Inverters Do:

Inverters operate somewhat like battery chargers in reverse: they take DC power from a battery and, utilizing sophisticated circuitry, change it into 120 Volt AC current. The ship's batteries are the inverter's fuel tank and, naturally, inverters can consume a lot. They will only provide 120 Volt AC power provided that there is ample juice left in the 12 Volt batteries. It is highly recommended that you have a separate, dedicated engine starting battery to avoid accidentally draining the entire 12v system.

Because inverters and battery chargers share certain electrical components, many models are available as combination inverter/charger units.

Most automatically switch almost seamlessly to battery charger mode when connected to shore power or if the generator is switched on, changing back almost seamlessly into an inverter mode when the AC power input is shut off. Most models have multi-stage chargers that prolong the life of your batteries by monitoring them and altering the charge rate according the battery's needs and condition. Since overcharging and poor charging are among the leading causes of battery failure, this is an important feature. Also, some inverter chargers may be set to optimally charge specific banks. You can program them regarding ambient temperature, battery temperature, bank size, battery type and other factors. This is a very desirable feature.

Choosing an Inverter

Before you can choose the appropriate inverter, you must first evaluate your power needs, including future additions. The key is to determine the maximum amount of 120 Volt AC power you and your crew will use at any one time, bearing in mind efficiency issues and the fact that the more you use the sooner you'll discharge the battery bank if you have no charging source, like a generator or engine alternator, running. Small inverters will operate a couple of smaller appliances simultaneously. If you wish to run the TV, VCR, and computer in the salon while a crew makes microwave popcorn, you'll need a larger capacity unit.

To determine the proper inverter size for your boat, make a list or spreadsheet of all the 120vAC equipment you will run, adding its wattage in a second column. If the appliances data plate states the power in amps, convert to watts using this formula:
Volts x Amps = Watts i.e. an item stated at 120 volts and 3 amps will draw 360 watts.

Add the wattage of all the appliances that you intend to operate simultaneously, ensuring you include any items, including a refrigerator, that run continuously. The total wattage run at one time is the minimum size inverter you should consider. However you should always purchase at the very least one size larger. You will probably discover more uses for your inverter after you've set it up-- and if you turn way too many loads on simultaneously, the inverter will overheat and shut down. Also adding up power requirements on labels of devices does not include efficiency loss and loss of voltage (leading to increased amp draw) through wire runs and possible resistance in connections and elsewhere.

Choosing the Right Inverter For Your Boat:
(Click on the links below to view the videos)

Part 1 – Energy Management Inverters

https://www.youtube.com/watch?v=fkwfydHVJMk

Part 2 – Fixed Mount Inverters

https://www.youtube.com/watch?v=uGSjMfKKga0

Part 3 – Fixed Mount Inverter/Chargers

https://www.youtube.com/watch?v=-NO5lOdic_Q

Choosing Batteries To Power the Inverters

Inverters depend on adequate type, size and number of ship's batteries for proper operation. To estimate the size and number of batteries you'll need, expand your list of appliance wattages by adding a third column for the amount of time you'll want to run each piece of gear in a 24-hour day. Since battery capacity is measured in amp hours, you'll need to build a forth column for adding up the amp hours required. Convert the watts to amp hours using this formula:

Example: the 13" TV uses 50 watts and you want to use it 2 hours each day, so 50/12 x 1.1 x 2 = 9 amp hours. If the data plate lists AC amps rather than watts, use this formula:

AC Amps x 10 x 1.1 x Hours of Use = Amp hours.

When your chart is complete, (see example below) you will see immediately which appliances are going to pull the most juice out of the batteries. Note that it isn't always the high draw items that cause problems-- the blender may draw six times the watts of the TV, but since its use is short, the TV has a much larger total. Now is a good time to reconsider high draw items, especially those with heating elements such as toasters, hair dryers, and waffle irons. You probably will not want to run these on an inverter, rather wait until the generator is on or until you're charging your batteries with an engine driven alternator.

In our example, a total of 397 amp hours is required to meet the power needs from the inverter in 24 hours. But the inverter's draw of 12 Volt DC from the battery to supply that AC demand will be more because of the efficiency loss, the energy required by the inverter to do its job and other factors. (Your inverter specifications should give you relevant information as to this.)

And you shouldn't draw down the batteries too low, and battery efficiency may be quite low depending on their age, the temperature and how well they've been charged and maintained. Therefore more battery power will be needed than the simple total. At a minimum you would want to add 50 % more battery capacity for a total of 596 amp hours.

Be aware that batteries age and die faster if "cycled," (discharged and recharged) frequently and even faster if cycled deeply (with deep discharges). Many battery manufacturers recommend that you double the needed capacity to avoid premature destruction of batteries-- in our example this would result in a bank with 794 amp hours. There are several different types of batteries that perform well but differently.

These include wetted lead acid (old fashioned but these were what powered submerged submarines before nuclear power, and still do on some subs), gel cell, AGM and others. Development of improved batteries is ongoing actively and before you buy you should investigate to learn about the latest products out there and what's most likely to suit your needs.

When constructing your appliance list, don't forget that the demands from the inverter aren't the only items your batteries have to handle. They still have to keep pace with all the 12 Volt DC users such as lights, electric head, water pumps, electronics and other systems. Also, the appliance list won't include power lost due to lack of efficiency and wire runs.

Inverter Options

Just as you monitor your car's fuel gauge, you must be aware of the status of your batteries. Most inverter manufacturers offer excellent remote panels, some with sophisticated battery monitoring systems. A few of the features available include low battery alarm, overload warnings, current in and out and the number of amp hours consumed-- all on a panel mounted in a conveniently visible location.

Every amp hour drawn out of the batteries must be replaced. If your boat has a generator or you plug into shore power at the end of each day, this may be of less concern. If you anchor for more than a few days without a generator, however, methods of replacing the batteries' expended juice must be considered. High-output alternators on the main engine, wind generators and solar panels can all be arranged to keep the system supplied with enough energy, depending on your usage. Although remember that running the main engine for long periods of time merely to power the high output alternator isn't very good because there isn't sufficient load on the engine.

All inverter installations require a large, dedicated 12 Volt fuse in the main power line from the battery to the inverter. Be sure to purchase the correct fuse block and fuse with the inverter-- it's always wise to carry a spare fuse if you plan a lengthy cruise. It is extremely important to follow carefully all the instructions in installation and operating the inverter. Larger inverters can consume a lot of DC power at times, and the wiring must be as specified by the manufacturer, not only to promote efficiency, but also to avoid fires and melt downs. A good unit will have a thorough set of instructions. Remember also that AC power from an inverter can cause fatal electric shock, just as it can if it's the shore power or generator. Proper wiring and circuit breakers and all other aspects of installation and operation, according to applicable ABYC (American Boat and Yacht Council) standards is important. And post warnings in appropriate places that, although the boat isn't "plugged in" wires and components may still be hot with AC current.

Appliance	**Wattage**	**Amps (watts/12)**	**Hours of Use**	**Amp Hours**
13" TV	50	4.1	2	9*
3 Cu Ft Refrigerator	150	12.5	8*	110
Icemaker	200	16.7	8*	146
Midsize Microwave	900	82.5	.25	21
Lamp	100	9.2	8	74
Coffee Maker	1,000	92	.25	23
Blender	300	27.5	2.8	2.8*
*** Based on 1/3 dezy cycle**				

Technology, knowledge and practices change almost daily therefore it is prudent to research for the very latest up to the date information and seek qualified professional assistance when needed.

Chapter 7: Marine Battery Installation:

Batteries should always be installed in a ventilated area. Batteries release explosive and flammable gases during the charging phase and should not be exposed to spark or flame.

When installing a battery in your boat, it is important to use either a box or a tie-down system to keep the battery stationary once underway. This will reduce unnecessary vibration. Make sure all connections to the battery terminals are tight.

To prevent charging problems when connecting batteries in series or series-parallel, do **not** mix old and new batteries or ones of different capacities or types.

Additionally, it is important to coat the terminals and connections with a corrosion inhibitor. The corrosion inhibitor should be reapplied every several months. Failure to do this will result in poor connections and wire corrosion, especially in salt-water environments.

Corrosion increases the resistance in the wires, requiring more amps to be drawn to run electrical equipment. When installing a new battery, be sure to remove any plastic battery terminal protectors before attaching wires.

It is extremely important not to mix battery types (Flooded, AGM). Don't use batteries of two different chemistries when connecting in series or parallel. Make sure the voltages are the same, but more importantly the charge rates and capacities are the same to help prolong battery life

Series Versus Parallel Installations:

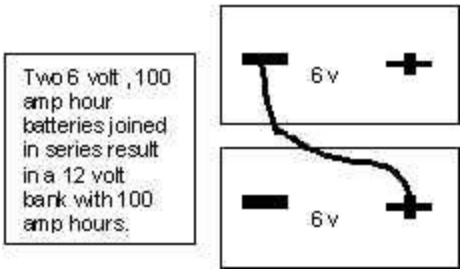
Batteries can be arranged differently to achieve increased capacity or increased voltage to match your specific requirements.

You may have heard some old salts at the marina talk about connecting batteries in series and connecting batteries in parallel. What's the difference ? First we must define another variable in our battery; amp hours. Battery capacity is expressed in amp hours. This means that if you had a 60 amp hour battery and everything that you were running off that battery collectively drew 10 amps, your battery would only be good for 6 hours.

The difference in series and parallel lies in what is increased by connecting the batteries and what remains the same.

The technique of connecting the positive terminal of one battery to the negative terminal of another you are, in effect, increasing the voltage while the amp hours remain the same. Some boaters use two 6 Volt deep cycle golf cart batteries to make up a 12 volt bank. This is done by connecting the two batteries in series.

Series Installation A series system increases the voltage and keeps the battery capacity the same. The same two batteries in a series arrangement will increase the voltage to 24 volts and maintain a battery capacity of 25 amp hours. To install batteries in series, one battery's positive post is connected to the second battery's negative post.



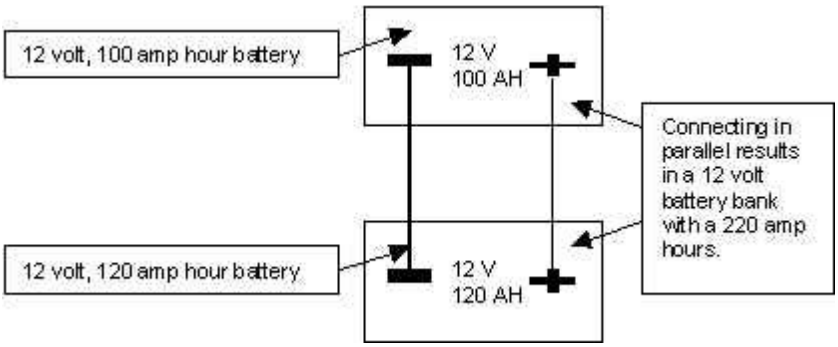
Parallel Installation:

You can arrange batteries in parallel to increase amp hours while leaving the voltage the same. You might ask; if I anchor out and use my lights, radio, anchor light, and 12 volt TV how long will my batteries last and still be able to start my engine in the morning? The answer is calculated by dividing the total number of amp hours in your battery(s) by the total of current (amps) drawn by the appliances

Two batteries connected + to + and - to - in a parallel system that increases capacity and maintains a specific voltage. This configuration doubles the power or amp hour rating of the battery while maintaining the voltage. Thus, two 25-amp hour, 12-volt batteries in parallel will give you a 50-amp hour 12-volt system.

Wiring batteries together in parallel has the effect of doubling capacity while keeping the voltage the same.

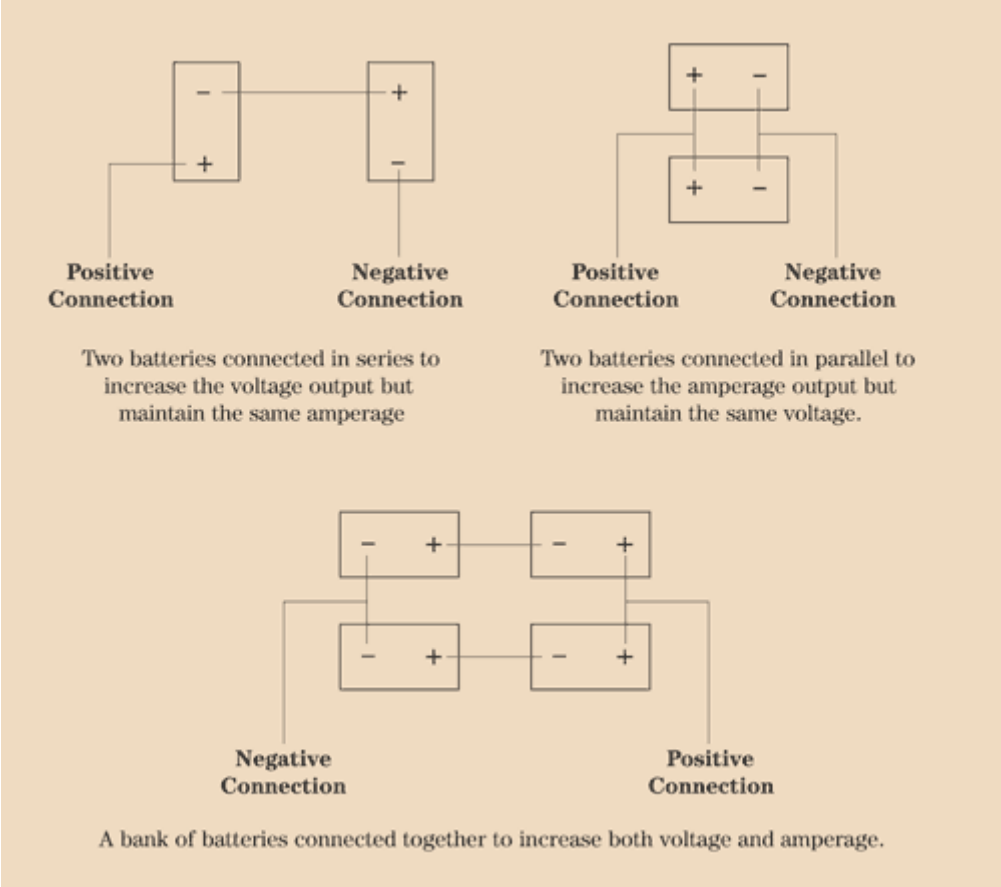
In order to increase the number of amp hours available to run your onboard 12-volt appliances, you can arrange any number of 12-volt batteries in parallel. Arranging in parallel is exactly the opposite of arranging in series. Rather than connecting the batteries from one's negative to the other's positive, you connect the positives together and the negatives together as illustrated below.



When connecting batteries in parallel be sure to use the same type of battery, for example; two deep cycle batteries. The age of the batteries should be the same. A new battery connected in parallel to an older one will not get fully charged, and the older battery may get overcharged.

Battery banks

Batteries can be joined together in two different ways – in series or in parallel. Batteries connected in series are connected positive to negative; this increases the voltage of the battery bank. Batteries connected in parallel are connected positive to positive and negative to negative. This increases the amperage of the battery bank. More than one battery bank can be connected together to increase either amperage or voltage. See diagram below.



Two batteries connected in series to increase the voltage output but maintain the same amperage

Two batteries connected in parallel to increase the amperage output but maintain the same voltage.

A bank of batteries connected together to increase both voltage and amperage.

Wiring Batteries in Series and in Parallel
https://www.youtube.com/watch?v=wdgq1-o1_8g

It's Time To Replace Your Battery When…

- **You had to jump-start your battery**
- **The battery can barely turn the starter over**
- **Lighting and electronics dim or go out when starting**
- **The battery will not hold a charge**
- **The battery becomes submerged**
- **The battery discharges frequently between use**
- **You buy a used boat**

Chapter 8: Choosing the Best On Board Marine Battery Charger:

Choosing an on board charger is important and, it requires careful consideration. You can't select a boat charger as you would a car charger because of the harsher environmental conditions facing marine chargers.

Environmental Conditions are an important consideration:

For example - moisture. An on board marine charger has to endure higher humidity and moisture conditions. Most boat battery chargers are moisture resistant to some degree to prevent premature failure from wet conditions. Usually, on board boat battery chargers aren't directly exposed to water because they are permanently mounted in the engine compartment or in another nearby location. A completely waterproof marine battery charger is needed when direct contact with water ocurrs such as in smaller fishing boats.

Battery Specifications: Another important consideration is the type of batteries in your boat and their amp-hour rating, as well as their voltage. .

What voltage charger do you need? Well, it all depends on your configuration.

Here are some examples. Single 12 Volt battery = 12 Volt battery charger
Two 12 Volt batteries setup in parallel = 12 Volt battery charger
Two 12 Volt batteries setup in series = 24 Volt battery charger

Do not use a 24 Volt battery charger to charge a 12 Volt battery. Doing so will damage or destroy your battery and charger and may also have dangerous consequences such as a fire or explosion.

Marine Battery Amperage: How many amp marine battery charger do you need? A simple calculation (that works in most cases) is to examine the amp-hour output rating of your battery and take 10% of that value as the proper amperage needed to recharge it.

If you have multiple batteries you will have to add up the amp-hours of all the batteries and multiply that figure by 10%. So in the case of three 105 amp-hour batteries, you would need approximately 10% of 315 amp-hours or 31.5 amps.

Smart Marine Battery Chargers: The best boat chargers are the new smart chargers that have onboard computer processors capable of detecting the state of your batteries and adjusting their output automatically. They can also be used as battery tenders providing a minimal charge to your batteries to keep them fully charged even during longer periods of downtime without overcharging.

Battery charging risks

Charging a boat battery seems, on the surface, to be a simple low-risk exercise, but again, the statistics tell a different story. Data shows that the charging of batteries has been the source of numerous fires involving runabouts and smaller fishing boats in which chargers are left connected for long periods of time. The result can be a burnt-out boat, garage or even house. If you are charging your boat battery, you should make sure that you check it regularly, as batteries can get extremely hot while being charged and can become a source of fire.

Marine Battery Charger Installation

Today, quality marine battery chargers use multi-stage charging including the monitoring of the voltage in the batteries. In fact, they may be left on continuously if they are installed correctly.

However, before you start you will need to determine where to locate the marine battery charger which should be as close to the batteries - but not too close.

One common mistake is to locate the battery charger directly above the batteries. Whilst it's important to keep the DC cables between your boat's battery charger and the batteries short; it's important to realize that batteries give off gasses and promote corrosion during charging. If you place the charger too close to the batteries, it will be exposed to these gasses, thereby shortening the charger's life.

Adequate ventilation is required so that it has breathing room and remains cool.

Always mount your marine battery charger in a compartment area that can be properly ventilated during use. Do not mix battery types on-board. All batteries should be of the same age and in good operating condition.

Do not make any electrical connections to your battery charger or batteries until the following steps are completed:

Select a mounting location that allows for free air ventilation with a minimum of 8 inches of clear unobstructed space around and in front of the Marine Battery Charger. Open all battery and engine compartments and ventilate for at least 15 minutes before starting the installation of the marine battery charger. Confirm all battery cables can reach each of the batteries and, do not install charger on carpeted, upholstered, vinyl, or varnished areas. Be sure to place the marine charger in an accessible area where all indicators are viewable. Install the unit on a hard surface.

Mark the position of each mounting hole and insure the mounting screws will not puncture or protrude into a live well, a fuel or oil tank or the bottom of the boat. Then apply a silicon sealer in each of the mounting locations to waterproof the screw holes.

Confirm the surface you will be mounting the charger to is adequate in strength and thickness to hold the marine battery charger in place with the mounting screws you have selected. Maintain an obstruction free area of 8 inches around the Marine Battery Charger.

The following video outlines how to install a Minn Kota Onboard Marine Battery Charger with two battery banks on a boat.

Also, he details how to lengthen the wire leads to each battery to extend the reach of the onboard marine charger. This charger will replenish you deep cycle marine batteries and maintain them with a maintenance cycle.

https://www.youtube.com/watch?v=7CKi8gBWQjQ

If you have a small boat like a sport boat, fishing boat or personal watercraft then it's bound to get wet, so you'll want to purchase a sealed or fully encapsulated marine battery charger which are designed for use in demanding environments. Boats with gasoline engines must use chargers that are ignition protected and conform to the appropriate UL specifications, which include testing in an explosive environment.

Once the location for the charger has been selected, it may be fastened in place. If the charger weighs more than a few pounds it should probably be through-bolted. If it is of modest weight, and the bulkhead or structure it is to be fastened to is sufficiently thick, then screws may be used. Be sure to use stainless steel fasteners.

Prepare each battery in advance by cleaning each terminal post with a wire brush until a shiny surface can be seen. Run cables free from sharp objects and hold each in place with cable ties. Coil excess cable, do not cut or shorten the length of the cables. We recommend the use of wire ties or cable clamps to provide strain relief for the cables and to reduce the risk of damage to the cables or connections.

Your battery charger will not operate properly if it is not connected properly to each battery. Make sure all connections are correct, tight, and free from corrosion. Ensure you wire your marine battery charger correctly. Your charger will not operate properly if it is not connected properly to each battery

Before starting up the system, check all connections for tightness. Check the battery voltage for a reference. Select the appropriate charging regime, so it will follow the right charging sequence and use the correct voltages for your flooded, gel, AGM or other compatible battery chemistry, per the manufacturer's instructions
You should also check to see whether the charger lives up to its rating.

Chapter 9: Charging batteries with battery chargers

Remember, you must put back the energy you use as soon as possible after use. If you don't the battery sulfates and that affects performance and longevity. Using correct marine battery chargers and methods extend battery life and range between charges. A battery should not be allowed to stand in a discharged condition because the sulfate coating on the plates becomes harder to remove as time goes by.

Marine battery chargers have three functions:

(1) Getting the charge into the battery (Charging)
(2) Optimising the charging rate (Stabilizing) and
(3) Knowing when to stop (Terminating).

You should charge new batteries completely before they are used the first time.

Charging time, using a marine battery charger, will probably be at least 12 hours as new batteries need up to four hours more charging time than "mature" batteries.

If possible, schedule enough charging time so that your marine battery charger shuts off automatically.

The age of the batteries, condition of the batteries, state-of-discharge, temperature of electrolyte, AC line voltage level, and other variables affect charging time.

Limit the use of new batteries between charging for the first 5-20 cycles. New batteries have less capacity than batteries, which have been broken in.

There are some important things that you should remember when it comes to charging your marine batteries. First of all, always become familiar with, and follow the instructions from manufacturers of marine battery chargers. When used correctly, marine battery chargers can double or triple the useful life of your batteries.

Batteries should be charged after each period of use. Lead-acid batteries do not develop a memory and need not be fully discharged before recharging. You should charge your boat's batteries only in well-ventilated areas and always keep sparks or flames away from a charging battery. Don't forget to verify that the charger voltage settings are correct. Check the electrolyte level (see the maintenance information) and tighten all vent caps before charging. Do not overcharge or undercharge the batteries; do not interrupt a charge cycle and never charge a frozen battery. In addition, avoid charging at temperatures above 120 degrees F.

Whenever possible, for longest battery life, recharge batteries as soon as they become 20% discharged. Never allow batteries to fall below 80% discharged. Deep discharging significantly reduces battery life.

Batteries in storage self-discharge and should be recharged whenever the specific gravity falls below 1.240. The rate of self-discharge varies directly with temperature.

A non sealed battery state-of-charge can be determined by using a hydrometer (a tool used to measure the specific gravity of the electrolyte solution) or by connecting the charger and observing the charging rate. If the ammeter needle jumps smartly to 20-25 amps and then tapers below 14 amps within 15 minutes, the battery is fully charged. When you test a battery with a hydrometer you are measuring the amount of sulfuric acid in the electrolyte.

If your reading is low, that means the chemistry that makes electrons is lacking. So where did the sulfur go? It is resting to the battery plates and when you recharge the battery the sulfur returns to the electrolyte.

What about leaving marine battery chargers plugged in ?

You can leave marine battery chargers plugged in until they kick off.

However, there are some things you need to consider. First of all, do not tempt fate by leaving boat chargers plugged in during a lightening storm. You should think about purchasing a very good surge suppressor.

Remember, the key to achieving optimum performance and long life is a solid marine battery maintenance program.

What voltage is my boat ?

Determining how many volts your boat uses is as easy as counting the water fill caps on the batteries. Check the marine battery compartment. The water fill caps are located on each battery. Each battery cell covered by a cap is 2-volts. Simply count all of the battery fill caps on your batteries, multiply this total by two, and you will have determined your boat's voltage.

Types of marine battery chargers:

Battery chargers for electric boats fall into two basic types; automatic (these are newer) and non-automatic (older). Both of these basic marine battery charger types have an ammeter on the font to show the number of amps being drawn by the battery pack, but otherwise they're very different.

The new generation of marine battery chargers are engineered for precision recharging to promote battery life and prevent overcharging mistakes.

You connect the battery pack to the charger and let it run. It sets the current flow, charge time and shut-off time automatically.

Any battery charger should initially start by providing at least 15+ amps to the batteries. The amps may drop down very quickly if the batteries are fully charged, but it should show at least 15 amps to start. If you know that the batteries need charging and the ammeter will not go above 15 amps, then you have a faulty charger and it must be repaired. The older non-automatic battery chargers usually have an On/Of Timer knob that switches the charger on or off and allows you to set the number of hours the charger will stay on, usually a maximum of 12 hours.

These older ones are typically for 36-volt systems although there are some 24 volt and 48 volt systems as well. The newer automatic chargers employ solid-state circuit boards that must sense some amount of voltage out of the battery pack to even come on at all. If the battery pack voltage is very low the charger will not come on, perhaps leading you to think that the charger is faulty, but this may not necessarily be the case. There are a number of things that can go wrong with a charger. Examples include: a burnt out transformer or circuit board with timer units, diodes and bad DC charger plates being the most common failures.

A battery charger converts AC power from the generator or from the power company into low voltage DC to charge a battery. An automatic marine battery charger offers the greatest convenience. Just plug the battery into the battery charger and the charger does the rest. Manual chargers, although equally effective at charging batteries, require a greater level of attention. Generally speaking, automatic battery chargers are priced higher than manual chargers.
Correctly charging batteries requires that you administer the right amount of current at the right voltage. Most charging equipment automatically regulates these values. However, some chargers allow the user to set these values.

For proper charging, you should always refer to the instructions that came with your charging equipment. While working deep cycle lead-acid batteries, please always wear safety goggles or glasses to protect your eyes in case of a battery explosion or electrolyte burns.

Chapter 10: Maintaining your marine batteries:

Improperly maintained marine batteries, can pose serious, even dangerous threats.

Some boaters assume that the batteries that operate their boats are maintenance-free.

A lack of knowledge about basic battery maintenance can lead to all kinds of problems. The key to achieving optimum performance and long life is a solid marine battery maintenance program.

It is recommended that you obtain following equipment for use in battery care and maintenance:

Wrench - Distilled water - Voltmeter (an instrument used for measuring the voltage between two points in an electric circuit) - Hydrometer (a tool used to measure the specific gravity of the electrolyte solution) –Please see the Chapter on How to use a Hydrometer, post cleaner - Baking soda - Petroleum jelly - Goggles and Gloves.

Tools, wires and metal objects can cause sparks when shorted across a battery or batteries. You should use insulated tools.

Important marine battery maintenance notes:

Battery acid is poisonous and can cause severe burns so always wear protective clothing, acid proof gloves and goggles when handling batteries and remove all jewellery. **Always** have baking soda and lots of water nearby because this will neutralise any acid spills from battery refilling. They also prevent further corrosive damage. Remember, the electrolyte is a solution of acid and water, so skin contact should be avoided. You should definitely avoid spilling acid on your boat. **Also**, do not smoke near marine batteries and never add acid to a marine battery.

Inspection steps for longer lasting batteries

In order to get the best performance from your batteries you need to have good connections across all terminals.

First of all, examine the outside appearance of the batteries. You should look for cracks in the container and the top of the battery. Posts and connections should be free of dirt, fluids and corrosion. You should replace any damaged batteries. Any fluids on or around the battery may indicate that electrolyte is spilling, leaching or leaking out and leaking batteries must be replaced. You should also check all battery cables and connections and look closely for loose or damaged parts.

Any cable that is broken or frayed should be replaced. Cables should be kept intact and tightly connected to the battery posts at all times. Tighten all wiring connections to the proper specifications and be sure there is good contact with the terminals. Use high quality, marine-rated cables and terminals to power the equipment. The most common questions are for battery cable sizes relating to either the motor, engine, trolling motor or inverter and each has it's own set of variables we need to find in order to make the correct calculation.

If you have any room for vibration on the battery terminal at all, you can melt the post and render the battery useless. Do not over-tighten terminals as over-tightening can result in post breakage, post meltdown or fire. Make sure there is good contact with the terminals.

Here's Two Resources for Information on Marine Battery Cables:

Choosing Cables and Terminals for Marine Service

Marine Wire and Service

Cleaning your marine batteries:

Check that all vent caps are tight. Then clean the battery top with a cloth or brush and a solution of baking soda and water ensuring that any cleaning solution or any other foreign matter does not get inside the battery. Then rinse with clean water and dry with a clean cloth. Solvents or spray cleaners should not be used. Then clean the battery terminals and the inside of the cable clamps with a post and clamp cleaner. Reconnect the clamps to the terminals and thinly coat them with petroleum jelly or anti-corrosion spray. Always keep the area around the batteries clean and dry.

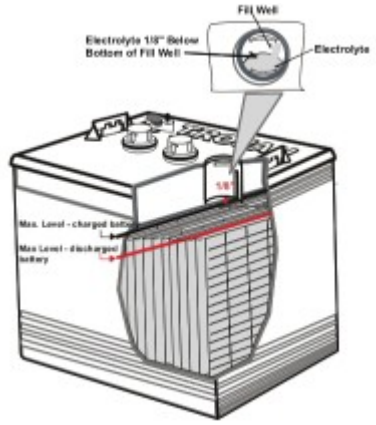
Watering:

Water should only be added after fully charging the battery. Prior to charging, there should be enough water to cover the plates. If the battery has been discharged (partially or fully), the water level should be above the plates. Some important things to remember are: Do not allow plates to be exposed to air and do not fill the water all the way up to the cap. Never allow the electrolyte level to fall below the plates. Do not use water with a high mineral content.

You should use only distilled or deionised water and you should follow this procedure: Remove the vent caps and check the electrolyte level ensuring the minimum level is to the top of the plates. If there is no electrolyte visible, add just enough water to cover the plates and then replace and tighten all water vent caps. Put batteries on a complete charge before adding any more water. (See Charging Chapter). Once charging is completed, remove the vent caps and check the electrolyte level. Add water until the electrolyte level just above the plates. Clean, replace and tighten all vent caps.

Lifespan of your marine batteries

Some marine batteries offer quick-release 3-gang vents, which allow you to check water for all three cells at the same time. The batteries have very thick plates and are designed for hours of heavy discharge each day, followed by a fast recharge in only a few hours each night.



Check water levels in each cell of each battery weekly to ensure that the leaded plates in the battery are submerged in liquid. Use only distilled water to refill, and don't fill the cell all the way up -- add just enough water to cover the plates. Don't forget to use safety glasses and heavy rubber gloves to check and refill the batteries.

The lifespan of a battery will vary considerably with how it is used, how it is maintained and charged, temperature, and other factors. Marine batteries can be destroyed, even without ever being used, in less than a year, because they're left without being charged. A marine battery can last between 2 and 6 years depending on how it's maintained.

As batteries age, their maintenance requirements change. This means longer charging time and/or higher finish rate (higher amperage at the end of the charge). Usually older batteries need to be watered more often and, their capacity decreases.

Inactivity can be extremely harmful to a battery. It is a VERY poor idea to buy new batteries and "save" them for later. Either buy them when you need them, or keep them on a continual trickle charge.

Storing your boat's batteries:

Avoid locations where freezing temperatures are expected. Also by keeping your batteries at a high state of charge as this also prevents freezing.

Avoid direct exposure to heat sources as temperatures above 80 degrees F accelerate the battery's self-discharge characteristics. If you are storing your boat and its batteries completely charge the batteries before storing and keep in a cool, dry location, protected from the elements. Stored batteries should be given a boost charge when they show a 70% state of charge or less. In addition, completely charge the batteries before reactivating.

At some stage you will have to remove your boat's batteries and with the seat-bottom removed, the boat's battery compartment can be accessed and the boat's batteries and battery cables can be removed.

Please follow the manufacturer's instructions for maintaining batteries.

Multimeter – An Invaluable Tool:

As previously mentioned, many of the problems that you will encounter on your vessel are electrical problems. It is because of this that the multimeter is an invaluable tool. With it you can do a lot of troubleshooting and track down potential problems without calling an electrician.

As with any piece of equipment, you should carefully read the manufacturer's instructions prior to use. Various multimeters have basically the same features but the features may be selected in different ways. Obviously, the more you pay the more features you will get.

Using a Battery Hydrometer

A battery hydrometer is a float-type device used that measures the concentration of sulfuric acid (specific gravity) of battery electrolyte ("battery acid") in lead acid batteries.

From this reading you can easily and accurately determine a non-sealed lead acid battery's State-of-Charge. A battery hydrometer is a glass barrel or plastic container with a rubber nozzle or hose on one end and a soft rubber bulb on the other. Inside the barrel or container, there is a float and calibrated graduations used for the Specific Gravity measurement.

The following is a list of instructions on how to correctly use a battery hydrometer.

If the battery's electrolyte is above 120° F (48.9° C), allow it to cool. Wear some glasses (preferably safety glasses) and gloves, in the unlikely event that a battery explosion or electrolyte spill might occur.

Lead acid batteries:

Hold a clean battery hydrometer vertically and then squeeze the rubber bulb. Then insert the nozzle into the electrolyte in the cell, and release the bulb. The electrolyte will be sucked up into the barrel or container allowing the float to ride freely. Start with the cell that is closest to the POSITIVE (+) terminal.

To dislodge any air bubbles on the float, tap the hydrometer. Squeeze the rubber bulb to release the electrolyte back into the battery's cell.

To increase the accuracy of the measurement, in the same cell, repeat this process several times so the float will reach the same temperature as the electrolyte. If you are measuring a large battery, stratification can occur when the more concentrated electrolyte settles to the bottom. If you notice a difference in the readings from electrolyte taken at the top and bottom of the cell, average the two readings.

At eye level and with the float steady, read the Specific Gravity at the point the surface of the electrolyte crosses the float markings. The Specific Gravity reading of marine batteries should be between 1.25 and 1.28 at 80 degrees Fahrenheit (this is the specific gravity of the electrolyte solution within the battery at 80 degrees compared with 1.000 being the specific gravity of water at the same temperature). As the charge drops, the specific gravity reading will drop and approach that of water.

Release the electrolyte back into the cell from which it was taken and record the reading. Be sure to avoid spillage. The acid solution should be 1.250 times heavier than water at this temperature. To correct for the air temperature at which the reading was taken, add or subtract .02 for every 5 degrees difference from 80 degrees. Repeat the process for each individual cell. The Specific Gravity reading should not have a difference of more that 30 "points" (.030) between the lowest and highest reading or 10 "points" (.010) below the battery manufacturer's recommended temperature value with the battery fully charged.

If so, try and equalize the battery by following the battery manufacturer's procedures. If equalizing does not help, replace the battery.

Determine the battery's State-of-Charge (SoC) by taking the average of the cell readings, but the battery's performance will be based on the weakest cell.

To test the marine batteries for distance, apply a battery load tester to see how they hold up with a 300-amp pull from the batteries.

Thoroughly rinse the hydrometer with water after using it.

Note: Do not equalize Gel or AGM batteries.

Chapter 11: Removing and Changing Marine Batteries:

Important battery disposal information:

Before you begin disconnecting battery cables, make sure the key is turned to OFF

Safety Note when removing your boat's batteries:

When undertaking battery disposal, always wear eye protection and ear protection, and follow proper safety precautions.

You should inspect all new batteries for any damage and to ensure that they are the proper battery for your vessel. It's not the first time that someone has replaced old batteries with incorrect ones and then wondered why their boat would not perform. Ensure the battery cables are still in good condition i.e. no fraying or melting, good crimps on the terminals and not corroded. If not, replace them. Check all battery hold-downs, (also called J bolts) and the battery rack. Be sure there are no foreign matter in the battery rack.

To keep track of the wires and connections, mark each cable being disconnected using tape and a marking pen, then mark the batteries with the corresponding letters. In this way you can keep track of which cable will need to be reconnected to which battery.

Once the cables and batteries have been marked, unbolt the battery cables starting with the positive cable, then the second positive cable and then the ground. It's not necessary, in this procedure, to unhook the cables between each of the batteries. Install the batteries and install battery cables in the right sequence. Make sure all connections are tightened. Spray the terminals with battery protector spray. Then fully charge before operation.

When you disconnect battery cables be careful to keep them from touching each other, battery posts and other wires.

Disposing of old marine batteries

All lead acid batteries are now classified as "hazardous waste"

Lead acid batteries have been determined to be unsuitable for disposal as municipal solid waste because they contain toxic heavy metals and have corrosive properties.

Boat deep cycle batteries are not to be placed in wastebaskets or dumpsters where they will end up as municipal trash.

So, what can you do? For starters, don't toss your boat's old deep cycle battery into a bin with your household recyclables and leave it on the curb. The deep cycle battery, also referred to as a lead-acid battery, contains about 21 pounds of lead, three pounds of plastic and one gallon of sulfuric acid. These items can be toxic if handled improperly.

If you are the do-it-yourself type, take your spent deep cycle batteries to someone who is committed to battery recycling.

Nearly 90 percent of all lead-acid batteries are recycled. Almost any retailer that sells lead-acid batteries collects used batteries for recycling, as required by most state laws.

Reclaimers crush batteries into nickel-sized pieces and separate the plastic components. They send the plastic to a reprocessor for manufacture into new plastic products and deliver purified lead to battery manufacturers and other industries.

Many states have regulations in place requiring battery recycling. (Thirty-seven states in the U.S. require lead-acid battery recycling; making retailers collect used lead-acid batteries from customers who buy new batteries.)

As neither sulphuric acid nor lead are exactly good for the environment you have to be careful when you dispose of old lead-acid batteries. Leave it for recycling. You can also leave your old battery where you buy your new one.

If that should not be the case, contact your local municipality to check where you can safely dispose of old batteries. In the old days, when we changed a battery, we threw out the old one and never gave it a second thought. Today, we know better. We know that:

- Individuals who become poisoned by lead can experience symptoms including irritability, stomach aches, poor appetite, diarrhoea, colic, distractibility, and lethargy;
- Lead acid typically consists of 40% sulfuric acid, a corrosive that can burn skin; and
- The improper disposal of lead-acid batteries can contaminate soil and water. The toxic metal is not able to dissolve in water or biodegrade, dissipate, decay, or burn, making it an extremely harmful hazard.

On a positive note it seems as if most people take this seriously. About 93% of all battery lead is recycled, making it the most highly recycled consumer product. Help in making sure we go towards 100%!

Chapter 12: Troubleshooting marine batteries

The experience of many, if not most, boat owners is that short battery life and dead batteries are a chronic problem. There are three primary reasons why battery problems occur:

Poor quality of batteries or inadequate battery power
Faulty installation
Faulty charging systems

The usual reason why boat batteries are dead is due to having the wrong type, size or quality to meet the vessel's demands. Truly good batteries are expensive and there are few boat builders that provide good batteries with new vessels; usually the quality is minimal, the amount of power inadequate, and the type ill-suited.

Often the first sign of a battery problem will occur when the starter won't turn the engine over. Use your multimeter to get a rough idea of the battery's state of charge. To perform a no-load test, set the digital multimeter switch function to Volts DC (V---) and measure across the terminals.

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The voltage test tells only the state of charge, not the battery condition. To gain additional information about the battery's condition, test the specific gravity of the electrolyte in each cell using a hydrometer. If the specific gravity is low but relatively the same across all cells, recharging may be able to bring the battery back to good health, unless the plates are sulfated. If one cell shows a specific gravity much lower than the rest, the cell is probably dead and recharging will not help.

In a lead-acid battery, each cell produces about 2.1 volts at full charge. Therefore, a 12V battery has 6 cells in series. If the no-load test reads 10V instead of 12V, a dead cell is likely and the battery should be replaced.

Starting systems:

Starting system troubles are often confused with charging system problems. Many dead batteries have been replaced when the real cause was a faulty charging system. Be sure that the charging system is functioning properly before you replace the battery. Make sure the battery is charged and passes a load test, then look for resistance in the starter circuit if the engine still cranks slowly. Investigate excessive current draw; check for worn-through insulation, a seized or tight engine, a faulty starter, etc. If the starter turns the engine slowly, the current draw is not high, and the battery is in good condition, check the resistance in the starter circuit.

Work safety:

The voltages and currents present in electrical power systems can cause serious injury or death by electrocution. Consequently, when testing or troubleshooting, carefully adhere to all industry standard safety rules that apply to the situation. Read and follow directions and safety warnings provided by the equipment manufacturer.

This eBook cannot anticipate all possible precautions that you must take when performing tests At a minimum, however, you should:

• Be sure that all power has been turned off, locked out, and tagged in any situation where you will be in direct physical contact with live circuit components - and be certain that the power can not be turned on by anyone but you.

• Use only well maintained test equipment. Inspect all test leads and probes and fuses before use. Repair or replace any test leads or probes with damaged insulation.

• Be very cautious when working on electrical systems when fuel vapors are present. Remember that vapor from gasoline and propane are heavier than air and will collect in the bottom of bilges and other closed compartments.

Sparks generated by making connections with live electrical components can start a fire or cause an explosion when fuel vapors are present.

• Be aware that charging of unsealed, lead-acid batteries generates hydrogen gas. This hydrogen can explode if exposed to a spark generated at the battery terminals when connecting or disconnecting a battery charger. Always verify that the battery charger power is off before connecting or disconnecting the charger leads at the battery terminals.

Why do my boat's batteries fail ?

Batteries fail prematurely because of a variety of reasons, including poor battery maintenance.

Why do my boat batteries not hold or take a charge ?

Batteries may not accept a charge for several reasons. Many chargers have minimum voltages that must be present in the battery before the charger will switch on. These low voltages are normally well below those exhibited by batteries that appear to be 'dead'. However, it's often the case that the batteries are not given the adequate amount of time to accept the charge.

One of the best tips regarding battery charging is to observe the charger's ammeter swing needle (available on some chargers) during the charging procedure. After the charger is connected to the battery and is on, the needle should deflect to a high amperage level if the battery is partially discharged. If the battery is severely discharged, the needle only deflects slightly away from zero. Continue to observe the needle in either situation. On a normally discharged battery only, the needle will start to taper in amperage back toward zero, usually in less than five minutes. This reduction in amperage typically indicates the battery is accepting a charge.

On a severely discharged battery, the needle will start off very low then rise. This rise of the needle is a preliminary indication the battery is accepting a charge. Remember, chargers vary in capability and **always observe safety procedures recommended by the charger manufacturer**. Always determine the battery's state of charge before and after recharging. The most accurate method for a battery with removable vent caps is the specific gravity test with a hydrometer.

My marine batteries start my boat sometimes but not at other times

This is probably not a battery problem. Make sure that all the connections are good. If the problem occurs only after the boat sits overnight or for a day or more before starting, the problem is often a low state of charge, so test your battery to determine its state of charge.

My batteries get corrosion build-up on the terminals:

Although all batteries contain highly corrosive sulfuric acid, corrosion should not occur under normal conditions without spillage or one of the following:

Overfilling: Add distilled water to the electrolyte of a fully charged battery if it is lower than 1/8" to 1/4" below the vent well at a full charge. If the battery requires charging, only add water if the electrolyte is at or below the plates.

Overcharging/overheating: Overcharging by the alternator or normal charging at an extreme battery temperature can result in excessive gassing of the battery, which may produce increased corrosion.

Inadequate metal contact: When current passes through poor or loose electrical connections, a form of corrosion may form.

Metallic exposure: When an electrical wire is exposed to salt particles in the air, corrosion will eventually occur. Remember to keep connections clean, tight and sealed by protectorates. Do not overfill the battery or allow it to become overcharged or overheated.

My batteries keep failing though I seldom use my boat:

Just like people, batteries need exercise to remain healthy. Exercise to a battery is getting recharged so it can remain healthy. Batteries will self-discharge while sitting unused.

Chapter 13: Marine battery questions answered:

Why can't I use a car battery on my boat ?

A boat requires a 'deep cycle battery. The term 'deep cycle,' put simply, means a battery that is designed to store a lot of energy, which can be drained and then recharged over and over again. In contrast, a starting battery, which is used in a car, is designed to deliver a quick burst of energy, but never become very drained, as it is continually charged up by the car's alternator. It is very important to only use a deep cycle battery on your boat with the correct type of charger as a car charger will shorten your boat battery's life very considerably.

Is it okay to leave my boat's battery charging for extended periods of time?

Leaving it to charge overnight is fine, but leaving it plugged in while on vacation is a bad idea. If there's an electrical storm while you're away, one lightning strike can destroy any number of other electrical parts.

Should I always keep my batteries charged?

Yes, you should never allow the batteries to become discharged for long periods of time. As a battery becomes discharged, lead sulfate begins to form, clogging the sponge-like pores in plates. If left uncharged long enough, it will ruin the battery. Also, if you live in a colder climate, keeping the batteries charged will prevent freezing. A fully charged battery will not freeze until 50 or 60 degrees F below zero.

I have a new boat. Do I let my batteries get completely dead before charging them ?

No. New batteries should be fully charged before you use them. They will need to be charged fully a number of times before reaching full capacity.

The battery pack - does it perform differently over time ?

Yes. As your batteries age, they will require water more often and longer charging times.

There was only one bad battery, so I replaced it. My boat ran OK for a while, but now it won't hold a charge again.

When batteries are connected in series, as they are in boats, you will need to replace an entire set rather than single batteries. Each battery in the pack needs to be approximately the same age, size and usage level. Do not put a battery in a pack that has more than 50 cycles on it. Instead, replace with all new.

How much water should I put in my batteries?

The water should completely cover the plates inside the battery, but should be about a quarter inch below the bottom of the fill tube. A battery filler bottle will automatically stop at the proper level, eliminating the guesswork. **Always try to use distilled water if possible.**

How do I test my batteries? What is specific gravity?

You will first need to purchase a hydrometer to perform this test. The specific gravity of boat batteries should be between 1.250 and 1.280 at 80 degrees Fahrenheit. This is the specific gravity of the electrolyte solution within the battery at 80 degrees compared with 1.000 being the specific gravity of water at the same temperature.

The acid solution should be 1.250 times heavier than water at this temperature. To correct for the air temperature at which the reading is taken, add or subtract .02 for every 5 degrees difference from 80 degrees. It is never recommended to add acid to your batteries unless the battery was spilled. Most of the acid is contained within the porous lead plates and does not readily evaporate. Usually, just add distilled water up to a quarter inch from the bottom of the battery fill tube.

The specific gravity only indicates the state of charge as measured by the amount of sulphuric acid in the electrolyte. As the charge drops, the specific gravity reading will drop and approach that of water. To test the batteries for capacity, you will need to apply a battery load test or a discharge test to see how they hold up with a 300-amp draw on the batteries.

How old are my batteries?

The battery codes will differ with the manufacturer, but only slightly. Below is the most commonly used date code system. The code will either be stamped into the battery posts or applied to the top of the battery with a sticker. The code can also be near one of the corners of the battery. This code tells when the battery was shipped from the factory.

The first digit from the left side is a letter, which stands for the month of the year. A = January; B = February; C = March, etc. The second digit from the left is the year that the battery was shipped from the factory (0 = 2010, 1 = 2011, 2 = 2012, 3 = 2013, 4 = 2014, 5=2015).

Battery Code Examples:
A=Jan 8=1998
B=Feb 9=1999
C=Mar 0=2000
D=Apr 1=2001
So a code of F9 would mean the battery was manufactured in June of 1999.

Can I replace just one of my batteries?

Yes, you can. **However**, there are some other considerations. If you have a single bad battery, and the batteries are not too old, replacement may not be a bad idea. However, if you have more than one bad battery, or they are 6 or 8 years old, it is recommended to change the whole set. If you place a new battery into a boat with old batteries, you will not get the full life or capacity out of the new battery. For lack of a better term, batteries tend to seek "the lowest common denominator".
The new battery's performance and capacity will be quickly brought down to the level of the used batteries. Replacing just one battery will result in a reduction in the overall performance of the new battery, but is more cost effective than replacing the whole set.

Beware, old batteries and cheap batteries will nickel & dime you to death. Once you start replacing more than one battery, the loss in performance can start to outweigh the cost of just biting the bullet and buying a new set of batteries.

Acid is bubbling out of my batteries! Is this normal?

Venting, or gassing, is a normal occurrence when your batteries are charging but this should not leave puddles of acid on the battery tops. If the batteries have been overfilled with water before charging then the cells may spill acid out. This is not good for the batteries, the battery racks & hold down brackets or battery cables & cable ends. If the acid is coming from anywhere other than the caps on top of the battery, you may have a leak. Spilled acid will ruin the smooth finish of a concrete garage floor, if left untreated.

How do I neutralize excess battery acid that has leaked out or bubbled over from my batteries?

Any acid can be neutralized by a simple base. You can use a professional acid neutralizing solution or a simple baking soda wash will work. Be sure that the caps are securely on your batteries and that you don't get any neutralizer inside the battery.

Chapter 14: Battery myths:

1. Storing batteries on a concrete floor will discharge them: False

All lead-acid batteries will naturally self-discharge.

2. Using a boat will fully recharge a battery: False

3. A battery can explode: True

Charging a wet lead-acid battery naturally produces hydrogen and oxygen gases as electrolysis of the water occurs and needs to occur in well ventilated areas. While spark-retarding vent caps help prevent external battery explosions, sparks occur connecting or disconnecting charger or battery cables and ignite the gas causing an explosion.

Should a battery explosion occur and battery electrolyte (battery acid) gets in someone's eyes, flush them out with any drinkable liquid immediately because SECONDS count. Continue flushing with water for at least 15 minutes, and seek immediate medical attention.

4. A battery will lose its charge sitting in storage: True

Depending on the type of battery and temperature, batteries have a natural self-discharge or internal electrochemical "leakage" at a 1% to 60% rate per month.

5. Do not use tap water to refill batteries: True

Use only distilled, deionized or demineralized water to replace the lost water in batteries because using tap or reverse osmosis water from residential systems can produce calcium or magnesium sulfate crystals that can fill the pores and coat the plates. In an emergency, use rainwater because rainwater does not contain calcium or magnesium.

Chapter: 15: Boat Winter Storage Tips:

Follow the tips below for proper storage of your boat during winter

Cleaning the Batteries:

Ensure all the cell caps are snugly attached and unplug the charger and wash the battery compartment. Start by spraying Battery Neutralizer all over the tops of the batteries. Be sure to spray it between the batteries, down on the battery racks, and the inside walls of the body panels, if they are metal. Use an old paintbrush to scour all the battery tops and sides. Water from a garden hose using plain water, or use a solution of Baking Soda (about 2 tablespoons to 1 gallon of water) to neutralize the acid.

Maintaining the battery terminals on your marine batteries:

Check, clean, tighten & treat all of the battery terminal connections. Be sure the cables are tight to the post. Carefully wriggle each cable end side-to-side and then gently up & down. There should be no looseness or sideways movement. If your battery terminals are badly corroded, you will need to do some serious cleaning. Check the water levels in each cell. Use distilled water to fill. Be sure the electrolyte (water) in each battery cell is above the plates. In cold climates, when the car will be left uncharged for several months, leave the water level a little low. This raises the specific gravity of the acid, which will help prevent freezing. A lead acid battery keeps much better in the cold than in the heat, as long as the charge stays up.
A fully charged battery will not freeze until 60 to 70 below zero whereas a discharged battery can freeze at 20 degrees above zero. As a battery discharges, the acid turns into water by the basic chemical nature of the lead acid battery. The more discharge, the more water and the more likely it is to freeze. Also a dirty, acid covered battery will self-discharge at a faster rate than a clean treated battery, even in cooler temperatures.

Don't leave your boat's batteries plugged into the charger for extended periods of time. After the charge is done, unplug the charger from the batteries and from the wall.

If you are not going away for the winter, you can plug your Charger in for a few hours once a month to insure a full charge is maintained. The charger should be unplugged after charging.

Finalizing for winter storage*:*

On small boats that aren't left in the water, you may want to take your batteries home and put them on a trickle charger. If you chose to keep them aboard, here are some tips: Top up wet-cell batteries with electrolyte.

Make sure battery cable connections are tight and free of corrosion — clean them if necessary with a pot scrubber or emery board. Coat the connections with a corrosion inhibitor like Boeshield T-9. Leave the batteries hooked up to a marine charger that has a float setting or leave them unplugged but charge them up completely at least once a month.

Batteries left on an automotive trickle charger for long periods of time run the risk of boiling off the electrolyte and, at the extreme, exploding. Today's batteries do best when charged using a marine "smart charger" that varies the charge based on differences in battery chemistry and matches charging voltage to what the battery can accept at different stages of the charging cycle.

When buying a marine battery charger, look for the following features:

• A three-stage charger with bulk, absorption, and float stages (or a four-stage charger with an additional prefloat stage) and battery type selection • Output of 25-40 percent of the battery bank capacity in amp hours
• Temperature sensing at the batteries for automatic adjustment of charger output
• Equalization phase for use with flooded cell batteries
• Ignition protection if installed in a gasoline engine room space

If your boat is going to spend a significant amount of downtime between outings, it is worthwhile disconnecting the battery terminals to retain the battery's charge and extend its life. Keep in mind that batteries lose charge over time anyway. In the case of engines running sophisticated engine management systems, you should consult with an authorised service centre to ensure you adhere to the factory-recommended procedure when disconnecting or reconnecting your battery. The main thing is that you have enough charge to start your engine.

If you have the old lead-acid batteries, check the electrolyte levels and the amount of charge, preferably using a dedicated load tester. When performing this check, turn on lights and other equipment to load the battery, as this will give you a true indication of its condition. Once you've completed your engine check, it's worthwhile starting it up to ensure the battery is up to the task. If it sounds like it's struggling to cope, get your local service centre to check it out. And lastly, make sure the battery is securely fastened.

Disconnect the battery cables; remove the battery from the boat. Clean the terminal ends and battery with a solution of baking soda and water, rinse thoroughly with clean water. Apply a light coat of grease on the terminal end of the battery and cables. Store the battery in a cool dry place. Use a trickle charger to keep battery charged . Do not charge battery near any open flame or in a confined area.

Electrical Test batteries. Top up electrolyte and equalise batteries Clean battery tops and connections □ Shut off power to all but required services.

It is strongly recommended that the batteries be removed entirely from the boat, but if you're one of those types who leaves them in, at least disconnect them (ALL CABLES). Turning the battery switch off is not good enough. Next, clean the terminals and tops of the batteries as any moisture or dirt will allow cross discharge between the posts. The batteries should be stored in a cool, dry place. Warm humid storage will promote cross discharge through the air. Charge the batteries at least every two months. Watch your water levels and top up as necessary.

Chapter 16: Battery Do’s and Don’ts

Battery Do's

Think Safety First.

- Do read this entire guide
- Do regular inspection and maintenance especially in hot weather.
- Do recharge batteries immediately after discharge.
- Do buy the highest RC reserve capacity or AH amp hour battery that will fit your configuration.
- Freshness - Check the date code on the battery to make sure it hasn't' been sitting on the shelf for ages. This can seriously affect performance. Batteries are perishable, so buy the freshest available

Battery Don’ts

Don't forget safety first.

- Don't add new electrolyte (acid).
- Don't use unregulated high output battery chargers to charge batteries.
- Don't place your boat into storage without some type of device to keep the battery charged.
- Don't disconnect battery cables while the engine is running (your battery acts as a filter).
- Don't put off recharging batteries.
- Don't add tap water as it may contain minerals that will contaminate the electrolyte.
- Don't discharge a battery any deeper than you possibly have to.
- Don't let a battery get hot to the touch and boil violently when charging.
- Don't mix size and types of batteries

Conclusion:

The bottom line is that having this basic maintenance done regularly – on the schedule recommended by the manufacturer – can drastically extend your boat's' batteries lifespan and improve performance.

Appendices A to E follow……

Appendix A – Boat Brands and Manufacturers

Here's a list of some of the main boat manufacturers:

Additional information may be obtained by visiting their web sites:

Boat Brands

American Boat Builders' Association

Maritime Catalogue for Boats

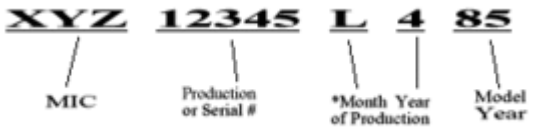
Appendix B: - The Hull Identification Number

Where do I look for the hull identification number?

The hull identification number (HIN) on all boats built after November 1, 1972 is permanently affixed to the rear of the transom usually on the upper right corner. It is required by federal law and must appear on the registration application.

The HIN consists of 12 letters and numerals at least one-quarter inch tall that indicate the manufacturer, hull serial numbers and/or letters, and model year and/or month.

HULL IDENTIFICATION NUMBER FORMATS FOR BOATS AFTER AUGUST 1,1984



Key to Month of Production of Hull Identification Format

Appendix C: - Resources:

Need help with your boat ? Check out the following resources

BoatUS Forum (Boat Owners Association of the United States)

Marine Engine (Boat Repair Forum)

The Hull Truth (Boating and Fishing Forum)

Cruisers Forum (Cruising Boats Forum)

Yachting and Boating World

Practical Boating

If you aren't sure about what you're doing or don't totally understand the concept/requirements, then please ask for more information or DON'T DO IT!

If done improperly you can possibly damage major components of your boat or get hurt.

Appendix D: Marine Battery Manufacturers:

The battery brand names listed below are popular batteries that should serve you well.

VMAX Marine Batteries

Optima Marine Batteries

Exide Marine Batteries

Odyssey Marine Batteries

Appendix E: Marine Battery Charger Manufacturers

The Marine Battery Charger Store provides you with the most popular marine battery chargers at the very best prices on the web. What's more, your order will be processed by Amazon.com the world's largest and most popular e-commerce website so you can be confident in using the store.

Deltran Battery Tender chargers

Black + Decker

Dual Pro Charging Systems

Guest Battery Chargers

Minn Kota Battery Chargers

Noco Genius Battery Chargers

ProMariner Marine Battery Chargers

Schumacher Battery Chargers

Appendix F: Electricity Systems

Electricity on boats can be scary, mysterious stuff.

The following video series will walk you through a simple system step-by-step:

Electricity Systems – Part 1

https://www.youtube.com/watch?v=tUul6kB9slo&list=PLWdeRCW4pvM3QgOWNFYJA7XjJcbetEiKX

Electricity Systems – Part 2

https://www.youtube.com/watch?v=GETAtxWuDxA&list=PLWdeRCW4pvM3QgOWNFYJA7XjJcbetEiKX&index=2

Boat Wiring, Part 3 - Proper Wire Type & Gauge, Ohm's Law

https://www.youtube.com/watch?v=TjkPR55_6zI&index=3&list=PLWdeRCW4pvM3QgOWNFYJA7XjJcbetEiKX

Electrical Systems Part 4 - Making Good Connections

https://www.youtube.com/watch?v=5DPtyfIm_LE&index=4&list=PLWdeRCW4pvM3QgOWNFYJA7XjJcbetEiKX

Boat Wiring Part 5 – Overcurrent Protection

https://www.youtube.com/watch?v=YK-uF6tkmSA&index=5&list=PLWdeRCW4pvM3QgOWNFYJA7XjJcbetEiKX

Boat Wiring Part 6 – Two Battery System

https://www.youtube.com/watch?v=Mn_ED4phg2I&list=PLWdeRCW4pvM3QgOWNFYJA7XjJcbetEiKX&index=6