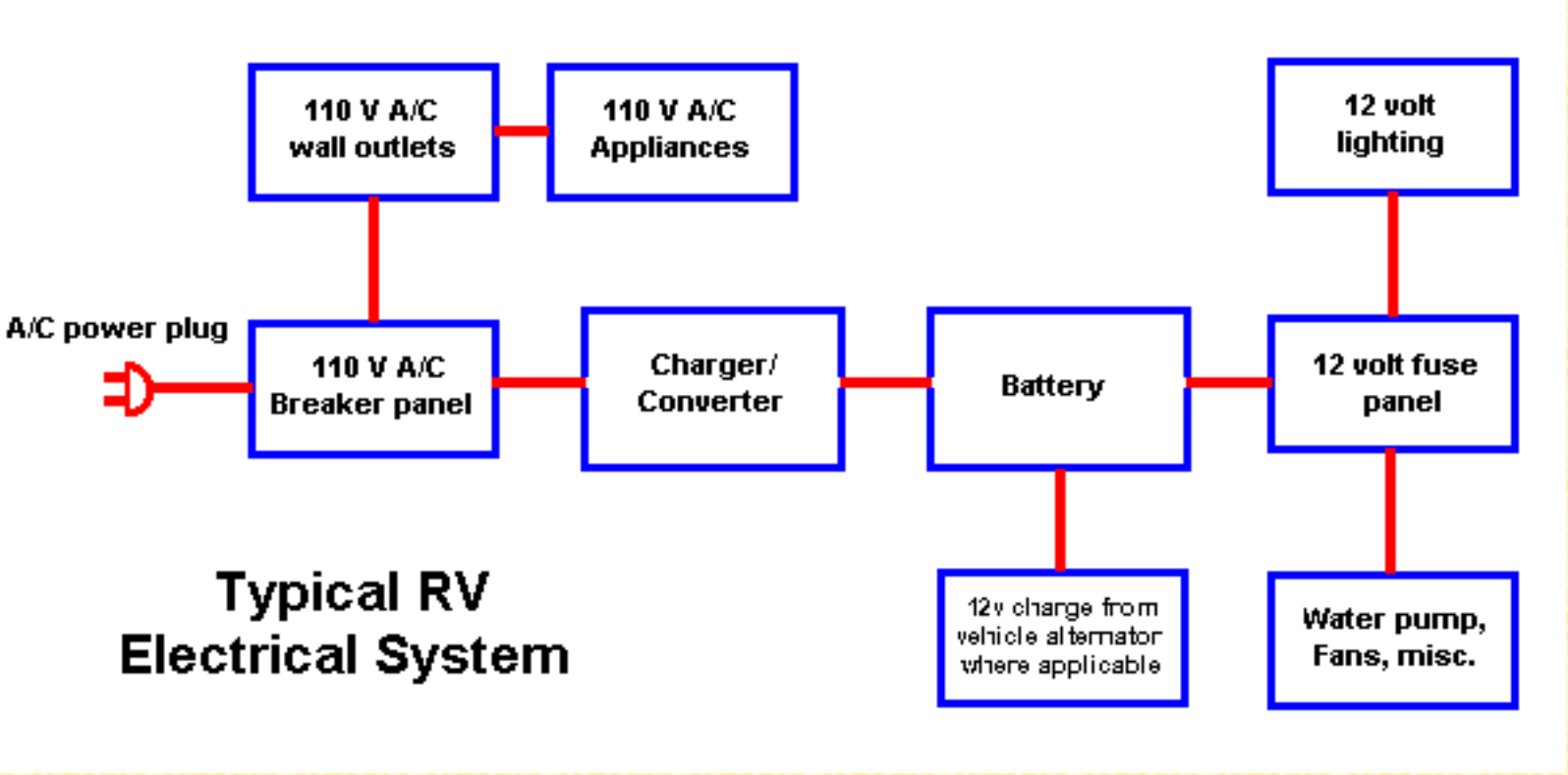
The 12volt Side of Life (Part 1).

Welcome to the page of all things 12 Volt! The information here was either excerpted from various sources on the web and in the public domain, or results directly from my personal experience. When researching battery specs for this page, I was amazed at the wide variance in some of the information. For instance; the charts that show voltage related to state of charge... almost every chart I looked at had different voltage values. I had to make a judgment call and pick the chart that best matched my own observations on my own 12 volt system. I tried to keep "opinion" to a minimum in the interest of putting out good, useful information, but where the sources of the information differ, I had to make an opinion call. Just so you know... the data on batteries contained herein is the best I can come up with, but may not be gospel. Some of the suggested RV modifications require you to be at least a little handy... Don't undertake any project beyond your capabilities and be especially careful anytime you are working in proximity to the batteries. They can be really dangerous if treated wrong... acid is caustic and batteries can explode if a spark or open flame ignites the hydrogen gas they produce. Shorting the output terminals of a battery can create huge sparks and sprays of molten metal (can you say "welding"?) When working with batteries, you need to have plenty of ventilation, remove jewelry, wear protective clothing and eye wear (safety glasses), and exercise caution. Whenever possible, please follow the manufacturer's instructions for testing, jumping, installing and charging. Use proper care at all times and don't EVEN try to sue me if you screw up... I warned you! Please see the disclaimer before proceeding!

- ## Introduction

  One of the best things about an RV is the self-contained power system that allows us to have all the comforts without being plugged into an electric outlet. This 12 volt system can be a joy or a headache, depending on how you maintain and utilize it. If you ignore basic maintenance, it'll let you down at the worst possible time! An understanding of the components and principles involved is necessary to get the most out of your 12 volt system. Relax, tho... it's not "rocket science"!.... your 12 volt system is simple and very easy to understand and maintain. Let's just take a look at a block diagram of a typical RV 12 volt system.



See.. there's really nothing to it! In the simplest terms, you have lights and other equipment such as water pump, fans, stereo, etc. that run on 12 volts, a battery that supplies the 12 volt power and some sort of charger to replenish the energy that you use from the battery. Of course, it's possible to add lots of useful components to this simple system to make it more flexible, but the basic 12 volt system in any RV starts with the components shown above.

As you read through this information, we will talk about all the different parts of this system and discuss some of the very useful additions and improvements that you can make yourself. Also included will be some highly technical info that you can bypass if it doesn't interest you. So, let's get started by talking about batteries. The battery is the heart of the 12 volt system. No other single component is as critical to the system's functioning as your battery system! That's why a lot of time needs to be spent talking about the care and feeding of your battery(s).

- **What's a battery?**

  Sure, we all know what a battery is.... it's that thing that goes dead when you leave the headlights on overnight! Actually, there's a little more to it than that, so perhaps a review of battery basics is in order here..

  A battery is an electrical storage device. Batteries do not make electricity, they store it, just as a water tank stores water for future use. As chemicals in the battery change, electrical energy is stored or released. In rechargeable batteries this process can be repeated many times. Batteries are not 100% efficient - some energy is lost as heat and chemical reactions when charging and discharging. If you use 1000 watts from a battery, it might take 1200 watts or more to fully recharge it. Slower charging and discharging rates are more efficient. Practically all batteries used in RV applications are Lead-Acid type batteries. Even after over a century of use, they still offer the best price to power ratio.

  Batteries are divided in two ways, by application (what they are used for) and construction (how they are built). The major applications are **automotive**, **marine**, and **deep-cycle**. Deep-cycle includes solar electric (PV), backup power, and RV and boat "house" batteries. The major construction types are **flooded** (wet), **gelled**, and **AGM** (absorbed glass mat). AGM batteries are also sometimes called "starved electrolyte", because the fiberglass mat is only 90% saturated with Sulfuric acid. Flooded may be standard, with removable caps, or the so-called "maintenance free" (without caps). All gelled are sealed and a few are "valve regulated", which means that a small valve keeps a slight positive pressure in each cell. Most AGM batteries are sealed and valve regulated. Sealed gell and AGM batteries offer the convenience of no maintenance and produce less gas, so at first glance, they may appear more attractive than standard flooded cell batteries. There is a down side here, tho.... These batteries, especially the gell cell type, require precise control of the charging process to prevent permanent damage by overcharging. They also tend to be significantly more expensive and have a somewhat shorter lifespan. It all depends on what premium you put on the maintenance free aspect of it. In my opinion, the standard flooded cell battery offers better overall performance for the price and will probably last a lot longer in most common RV applications. The need to add water periodically is a small price to pay for the advantages you get. I strongly suggest that you avoid the "maintenance free" flooded cell batteries... they truly aren't a good design: they are simply a standard flooded cell battery with sealed cells. Each cell has a small

valve to release excessive pressure. They still can be run low on electrolyte with heavy usage and fast charging, and there's no way to add water, so the batteries often die young.

It's important to understand the differences in battery types...

Starting batteries are normally used to start and run engines. Engine starters need a very large starting current for a very short time. Starting batteries have a large number of thin plates for maximum surface area. The plates are composed of a Lead "sponge", similar in appearance to a very fine foam sponge. This gives a very large surface area, but if deep cycled, this sponge will quickly be damaged and will fall to the bottom of the cells. Automotive batteries will generally fail after 30 or more deep cycles.

Deep cycle batteries are designed to be discharged down as much as 80% repeatedly, 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. Unfortunately, it is often impossible to tell what kind of battery you are really buying in some of the discount stores or places that specialize in automotive batteries.

Many **Marine batteries** are actually "hybrid", and fall between the starting and deep-cycle batteries, while a few are true deep cycle. In the hybrid, the plates may be composed of Lead sponge, but it is coarser and heavier than that used in starting batteries. It is often hard to tell what you are getting in a "marine" battery, but most are a hybrid. "Hybrid" types should not be discharged more than 50%.

A battery's capacity for storing energy is rated in several different ways, depending on the battery type. Starting batteries are often rated in Cold Cranking Amps or CCA. CCA is the discharge load in amps which a battery can sustain for 30 seconds at 0 degrees F. and not fall below 1.2 volts per cell (7.2V on 12V battery). This battery rating measures a burst of energy that a car needs to start on a cold morning.

Deep cycle batteries are often rated in Amp/Hours. Amp/Hour rating of battery capacity is calculated by multiplying the current (in amperes) by time (in hours) the current is drawn. For example: A battery which can deliver 4 amperes for 20 hours before being discharged would have a 80 amp-hour battery rating (4 X 20= 80).

You may also see batteries rated with a Reserve Capacity. RC is the number of minutes a new, fully charged battery at 80 degrees F. will sustain a discharge load of 25 amps to a cut-off voltage of 1.75 volts per cell (10.5V on 12V battery). This battery rating measures more of a continuous load on the battery. For RV use, this rating is a little less useful, as the common loads that RV use puts on a battery are a lot less than that 25 amp load used to determine RC.

I feel that the best bet is to consider batteries by their amp/hour rating, so that is the rating method used throughout this article.

- **Selecting batteries**

Now that we know a little more about batteries, it becomes obvious what we should be using in the RV. Deep cycle batteries! When you unplug from the A/C line and go boondocking for a weekend, you are using only your batteries to provide power for your rig. It's not uncommon for those batteries to be fairly well discharged before you get back to civilization and plug in. Starting batteries and "Marine" batteries just aren't designed for this kind of use and will die an early death in your RV. Use only deep cycle batteries! This is so simple that you'd think it would be a no-brainer, but a lot of RVs (especially used ones!) leave the dealer's lot with starting or Marine type batteries installed. If you recently bought your rig, it may be worthwhile to check and see just what batteries you actually have installed.

Selecting the correct batteries is all about lifespan.... The right batteries will last a lot longer, leaving you with more money for the finer things in life! The lifespan of a battery will vary considerably with how it is used, how it is maintained and charged, temperature, and other factors. We'll talk more about maximizing the lifespan of your batteries later, but for now, here are some typical expectations for batteries used in deep cycle service:

Starting: 3-12 months
Marine: 1-6 years
Golf cart: 2-8 years
Deep cycle (L-16 type etc.): 4-8 years

AGM deep cycle: 4-10 years
Gelled deep cycle: 2-5 years

A lot of RVs come from the dealer with just a single Group 24 deep cycle or Marine battery installed. Many have room for additional batteries and some battery boxes will accommodate larger batteries. Now, folks... if you NEVER camp without electric hookups, you need worry little about battery selection... in fact, you might as well not bother reading any further. On the other hand, if you like to really get away from it all and consider hookups optional at best, then a good rule of thumb is to get as large a battery as will fit in your existing battery box... The more amp hours of capacity you can fit, the longer you can go between re-chargings.

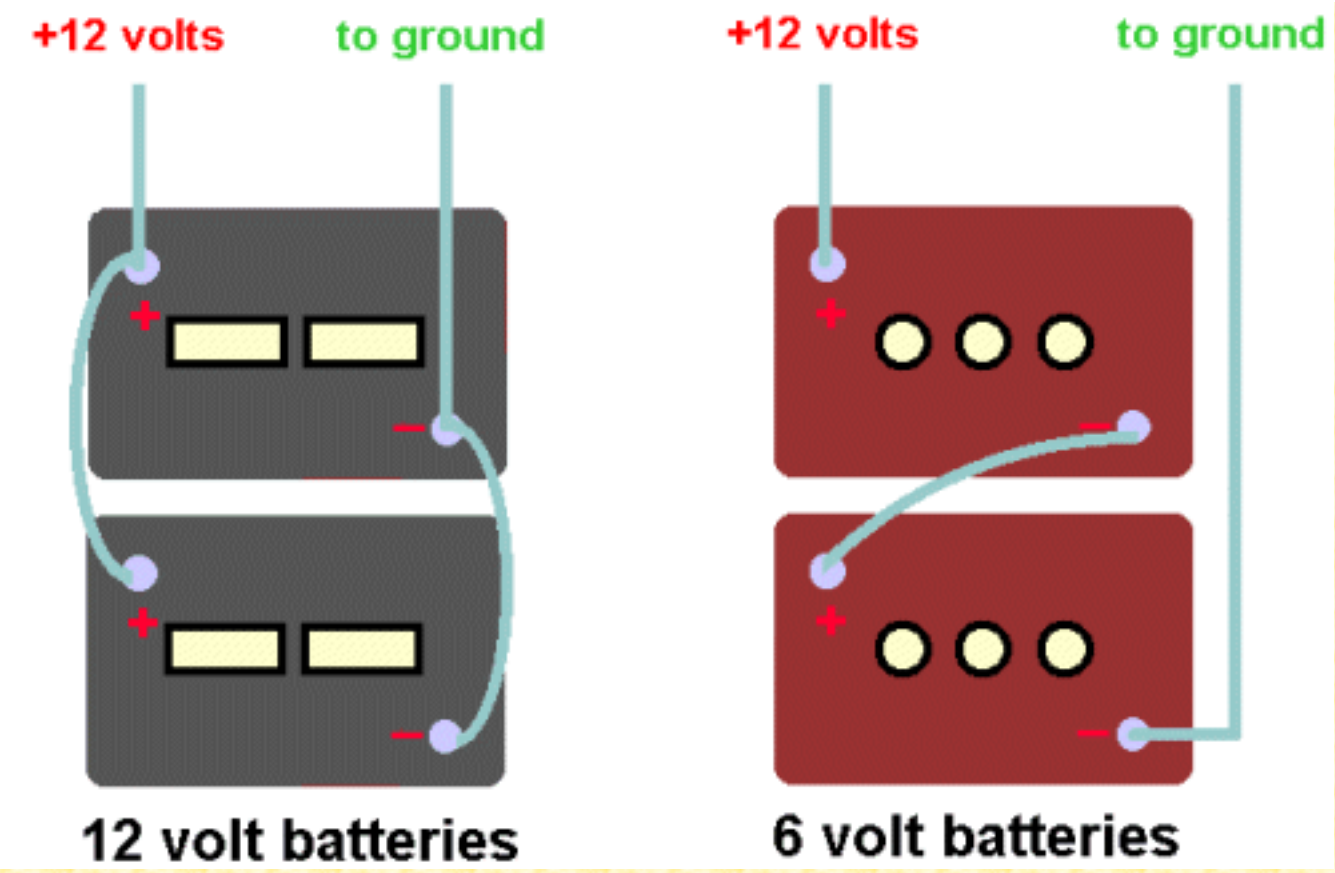
There are a lot of different battery sizes out there... here are some common battery size codes and approximate sizes and ratings:

Battery Type	Dimensions in inches (L x W x H)	Weight	Capacity	Voltage
Group 24	10.87 X 6.58 X 9.97	53 lb.	70-85 Amp hours	12 volts
Group 27	12.60 X 6.60 X 9.97	63 lb.	85-105 Amp hours	12 volts
Group 31	12.94 X 6.74 X 9.88	68 lb.	95-125 Amp hours	12 volts
4-D	20.73 X 8.66 X 10.27	130 lb.	180-215 Amp hours	12 volts
8-D	20.62 X 10.95 X 10.17	158 lb.	225-255 Amp hours	12 volts
10.37 X 7.13				

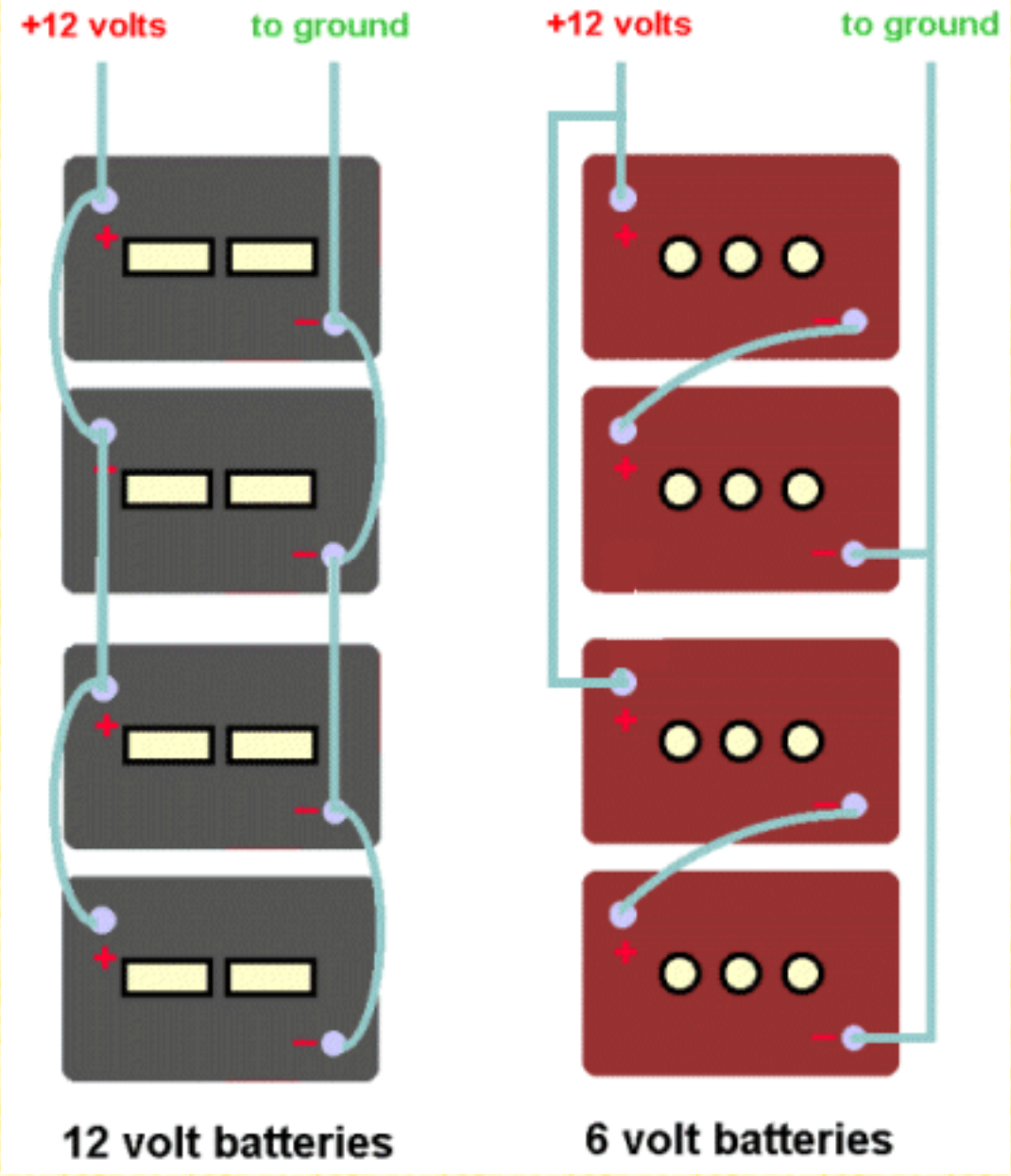
Golf cart & T-105	10.37 X 7.13 X 11.57	61 lb.	180 to 220 Amp hours	6 volts
L-16	11.69 X 7.13 X 16.69	114 lb.	340 to 380 Amp hours	6 volts

A lot of RVers have switched from the "standard" group 24 or 27 12 volt batteries to the larger 6 volt golf cart batteries. If you have room for at least 2 of them, they are a good choice. They are true deep cycle batteries and will last a lot longer than most common 12 volt batteries in your RV. They are physically larger, so you must measure carefully before buying them, but I recommend you use them if you can. I have a set of Trojan Golf cart batteries that are going on 5 years old and they still have almost all of their original capacity. They are priced about the same as (or a bit lower than) the common 12 volt deep cycle battery. Golf cart batteries have a higher capacity than group 24 and 27 batteries... a pair of group 24 12 volt batteries only provide 140-170 amp/hours of capacity, where a pair of golf cart batteries provide 180-220 amp/hours. There are other deep cycle batteries available, such as the L-16 and AGM types, that are extensively used in large solar and alternate energy systems, but their physical size and added expense make them a less attractive choice for the average RVer.

If you have room and want to change over to the 6 volt golf cart batteries, you must make an important wiring change. Most rigs that have 2 or more 12 volt batteries have them wired in parallel. when going to the 6 volters, you must wire pairs of them in series to produce the needed 12 volts. This is actually simpler than it sounds.... see the diagrams below.



When installing new batteries, first mark the cables so you do not forget which one is which when you reconnect. If you are changing over from a pair or set of 12 volt batteries to a pair or set of 6 volt batteries, some changes in cabling will be required. See the wiring drawing above for an example.. If you don't fully understand what the difference is between parallel and series wiring, I strongly suggest that you do not attempt to do the hookup yourself... get a competent RV mechanic to show you how. If you are building a bigger battery bank, see below for wiring info...



When replacing your batteries, remove the **negative** cable first because this will minimize the possibility of shorting the battery when you remove the other cable. Next remove the **positive** cable and then the hold-down bracket or clamp. If the hold down bracket is severely corroded, replace it. Dispose the old battery by exchanging it when you buy your new one or by taking it to a recycling center. Please remember that batteries

contain large amounts of harmful lead and acid.

After removing the old battery(s), be sure that the battery tray and cable terminals or connectors are clean. Auto parts stores sell a cheap wire brush that will allow you to clean the inside of a terminal clamps and the terminals. If the terminals, cables or hold down brackets are severely corroded, replace them. Keep track of the markings you made on the cables before replacing them!

Thinly coat the terminals and terminal clamps with a high temperature grease or petroleum jelly (Vaseline) to prevent corrosion. Place the replacement battery(s) so that the cables will connect to the correct terminals. Be extra careful here, as reversing the polarity of the battery when connecting it may severely damage or destroy some parts of your RV electrical system. Replace the hold-down brackets or straps to secure the batteries in place, then reconnect the cables in reverse order, i.e., attach the **positive** cable first and then the **negative** cable last.

Before using the battery(s), check the electrolyte levels and state-of-charge. Refill or recharge as required.

A word of Caution: If you have decided to add additional batteries to your rig, be sure to either use the existing battery compartment or a compartment specially designed and vented for batteries. Never place batteries in an unvented compartment as potentially explosive hydrogen gas will build up. Never place batteries in any compartment where electrical sparks or other ignition sources may exist. (a simple 12 volt light with a switch on it is an excellent source of ignition spark!!) Notice that the existing battery compartment on your rig is (or, at least, it should be!!) isolated from all other areas of the rig and possible ignition sources. Also, be sure to secure batteries with straps or brackets to prevent movement when the rig is in motion. An unsecured battery may tip over and spill acid, or worse, may short out against the rig frame or other metal objects and cause a fire. If you are setting up a new battery bank in your rig, **don't do a half-assed job!**

- **Care of your batteries**

Now that you have made the choice of what kind of batteries you will use, and have successfully installed them

in your rig, it's time to talk about maintenance. In order to get the most from your new batteries, you can't just forget them now and expect them to work for you forever. It is very important to take good care of your new batteries and treat them right.

You must keep an eye on the electrolyte level in the batteries. Most premature failures are caused by low electrolyte levels, and there's just no excuse for it, as it's simple and cheap to keep the batteries filled to the top. Electrolyte is lost whenever the batteries are charged and also when the batteries are discharged heavily. You should check the level in each cell of your batteries regularly. I recommend at least once a month, but it may be necessary to check and top off your batteries more often, depending on usage and how you charge them. At all costs, you must keep the electrolyte level above the plates at all times. In the warmer climates and during the summer, check the electrolyte levels more frequently. To replenish the electrolyte, add **distilled water** as required. Never add acid-- just distilled water and do not overfill. **Never** use anything except distilled water! Tap water contains a lot of chemical and mineral impurities and will kill your battery before it's time.

A word of Caution: Batteries contain a sulfuric acid electrolyte which is a highly corrosive liquid. Don't get any on you! In case of a spill or splash, immediately flush the affected area with lots of cold water to dilute the acid. A mixture of baking soda and water can also be used to neutralize the acid, but watch out for the foam that will be generated! Be careful and pay attention to what you are doing! Also, avoid generating sparks, smoking or open flames in the vicinity of batteries.... batteries produce flammable hydrogen gas (remember the Hindenburg?) and can explode violently if the gas is ignited. This is especially important when batteries are housed inside any sort of compartment. Again, protective clothing and safety glasses are recommended to protect you in case of accident. Please treat batteries with the respect they deserve.

Maintaining the correct electrolyte levels, tightening loose hold-down clamps and terminals, and removing corrosion is normally the only preventative maintenance required for a battery. However, you can extend your battery's life by keeping your battery charged properly and avoid deep discharges. Let me explain:

A battery "cycle" is one complete discharge and recharge cycle. It is usually considered to be discharging from 100% to some point not lower than 20%, and then charging back up to 100%. Battery life is directly related to how deep the battery is cycled each time. If a battery is discharged to only 50% each cycle, it will last about

twice as long as if it is cycled to 20%. Running the battery down totally flat will have a very negative effect on the lifespan of the battery. See the table below for voltages as related to depth of discharge. This chart is designed to be used when monitoring a battery under load. This chart is a little more useful to the average RVer, as we are most interested in monitoring the state of charge of our battery bank while it is actually in use. See the Testing your batteries section below for information on determining **open circuit** state of charge using either a volt meter or a specific gravity tester.

(For a printable GIF of this table, Click HERE.)

Voltage	State of Charge
12.6+	100%
12.5	90%
12.42	80%
12.32	70%
12.20	60%
12.06	50%
11.9	40%
11.75	30%
11.58	20%
11.31	10%
10.5	0%

Avoid discharging the battery below the 40% level whenever possible.

If the battery has been charging, then it's important to let the battery set for 2 to 3 hours without a load or charger connected to stabilize before testing. Otherwise, your reading will be high, caused by a phenomenon called "surface charge" It is also necessary to invest in a good digital voltmeter.... it's the only meter that will offer the necessary accuracy to properly test your battery system. That little analog gauge that is part of your RV monitor panel is not very accurate or useful. It's possible to install your own panel mount digital voltmeter... I'll tell you more about that in the section on monitoring. For now, it's important that you understand that your battery's life is adversely affected by too deep a discharge.

At this point, it's also important to note that the battery voltage will be affected by temperature.... The chart above, and most other ratings applied to Lead/Acid batteries assume that the battery is at room temperature: 21 degrees C or about 70 degrees F. As the temperature of the battery drops, so will the fully-charged voltage reading. I have found a lot of conflicting information about this phenomenon, but it seems to be safe to say that for each 10 degrees F drop in temp, you can expect to see the voltage drop about a tenth of a volt. (.10 volt) That means that a battery at 32 degrees F with a no-load voltage reading of 12.35 volts is fully charged.

Battery capacity (how many amp-hours it can hold) is reduced as temperature goes down, and increased as temperature goes up. This is why your car battery dies on a cold winter morning, even though it worked fine the previous afternoon. At freezing, the battery's capacity is reduced by 20%. At approximately -22 degrees F (-27 C), battery AH capacity drops to 50%. Capacity is increased at higher temperatures - at 122 degrees F, battery capacity would be about 12% higher. Even though battery capacity at high temperatures is higher, battery life is shortened. Battery capacity is reduced by 50% at -22 degrees F - but battery LIFE increases by about 60%. Battery life is reduced at higher temperatures - for every 15 degrees F over 77, battery life is cut in half. In reality, this is fascinating information, but isn't really terribly important. Most RVers experience a wide range of temperatures and conditions, so your batteries will average out just fine... I only include this information to give you some feel for the fact that temperature plays a part in battery life and capacity. Don't worry about it!

You should recharge a deep cycle battery as soon as possible after each use. It is very hard on a deep cycle battery to sit for extended periods in a partially charged state. To charge the battery, you can use a wide variety of methods. Most RVs provide some sort of converter/charger to "charge" the batteries when you're

plugged into an A/C source. Most rigs also have some sort of provision to charge the house batteries from the motorhome or tow vehicle engine. We'll get into that in detail in the next section.

- **Charging your batteries**

  OK, for you techie types, here are the specs for charging deep cycle flooded cell batteries:

  Most flooded batteries should be charged at no more than the "C/10" rate for any sustained period. "C/10" is the battery capacity in amp/hours divided by 10. For a 220 AH battery, this would equal 22 Amps. Charging at 15.5 volts will give you a 100% charge on Lead-Acid batteries. Note that flooded batteries MUST bubble (gas) somewhat to ensure a full charge, and to mix the electrolyte. Float voltage for Lead-Acid batteries should be about 2.15 to 2.23 volts per cell, or about 12.9-13.4 volts for a 12 volt battery. Flooded battery life can be extended if an equalizing charge is applied every 10 to 40 days. This is a charge that is about 10% higher than normal full charge voltage, and is applied for about 2 to 16 hours. This makes sure that all the cells are equally charged, and the gas bubbles mix the electrolyte. If the liquid in standard wet cells is not mixed, the electrolyte becomes "stratified". You can have very strong solution at the top, and very weak at the bottom of the cell.

  So you ask: "what does all that mean?" It means that battery charging is a little more complicated than most people think. It's not really safe to assume that driving your motorhome will keep your house batteries up to par, or that plugging your trailer in to A/C power and letting the converter run will make everything hunky-dory. The truth is, most of the RVs on the road have very poorly designed battery charging systems courtesy of the factory. Why? Well, cost plays a key role in deciding what equipment a RV will have installed when it's sold. Most RVs depend on the 12volt converter to charge the house batteries. In most cases, that's a very poor compromise!

  The life of your batteries will be longer and happier if you charge them correctly. The best chargers on the market are 3-stage chargers. Use of a good quality 3 stage charger will significantly improve your battery's performance and lifespan. These chargers can be purchased separately or are included as part of many of the

better quality inverters. When using a 3 stage charger, battery charging takes place in 3 basic stages: Bulk, Absorption, and Float.

Bulk Charge - The first stage of 3-stage battery charging. Current is sent to batteries at the maximum safe rate they will accept until voltage rises to near (80-90%) full charge level. Voltages at this stage typically range from 10.5 volts to 15 volts. There is no "correct" voltage for bulk charging, but there may be limits on the maximum current that the battery and/or wiring can take.

Absorption Charge: The 2nd stage of 3-stage battery charging. Voltage remains constant and current gradually tapers off as internal resistance increases during charging. It is during this stage that the charger puts out maximum voltage. Voltages at this stage are typically around 14.2 to 15.5 volts.

Float Charge: The 3rd stage of 3-stage battery charging. After batteries reach full charge, charging voltage is reduced to a lower level (typically 12.8 to 13.2 volts) to reduce gassing and prolong battery life. This is often referred to as a maintenance or trickle charge, since it's main purpose is to keep an already charged battery from discharging.

- **Converters vs. real battery chargers**

As stated above, the converter in your RV really isn't designed to be a decent battery charger. It's main purpose in life is to provide 12 volt power for your rig while you are plugged in to an A/C outlet. Since the converter is designed to not exceed a voltage of about 13.5 volts, it will never fully charge your batteries. Also, after it has succeeded in partially charging your batteries, it will then commence to boil off electrolyte, as the "float" voltage is too high (should be about 13.2 volts max.). If you plug your rig into A/C power for months at a time, you MUST keep a close eye on your battery's electrolyte level. It is very common for a converter to boil a battery dry in a month or two. Don't let it happen to you! If you must live with your converter, it is a big help if you unplug it or switch it off when the rig is in storage and attached to A/C power. Just run the converter overnight once a month or so and it will be much easier on your batteries. Another significant disadvantage to the converter is that most units aren't capable of delivering their rated amperage to the batteries to charge them. Older converters will only manage about 10 or 15 amps and will put out significantly less when powered by a

generator.

A much better choice is to replace your converter with a modern 3 stage battery charger. These units are fully automatic and can be left plugged in continuously without damaging your batteries. They provide much higher charging current than a converter and will fully charge your batteries in short order, even on generator power. Many better inverters include a 3 stage battery charger as part of the unit. You can also buy just the charger and replace your existing converter with it, as it will handle all the functions of the converter and keep your batteries in shape too! Unfortunately, these chargers aren't cheap... you can expect to pay from $50 to $400 for one, depending on ratings and features. Still, if you need to replace a failing converter or are considering getting an inverter, don't miss the chance to get a 3 stage charger. They really are worth the money if you use your batteries a lot.

- **Testing your batteries**

This section gets a bit technical, but is included to help you diagnose battery problems. If your 12 volt system isn't performing as well as you expect, it's time for some tests to determine what's wrong...

First off, visually inspect for obvious problems.... for example; damaged cases, corroded terminals or cables, loose hold-down clamps or cable terminals, or low electrolyte.

If you have just recharged your battery, then a phenomenon known as "surface charge" will cause the battery voltage to be higher than normal. To insure accurate readings, you must eliminate any surface charge before testing. Use one of the following methods;

1. Allow the battery to sit for six hours with no load or charger connected, or...
2. Apply a 25 amp load for three minutes and wait five minutes, or...
3. With a battery load tester, apply a 150 amp load for 10-15 seconds.

The battery under test must be disconnected from any load or charger when testing. This is referred to as

"Open Circuit". Use the following table, determine the battery's state-of-charge. The best way to measure the state-of-charge is to check the specific gravity in each cell with a hydrometer. A temperature compensating hydrometer will cost approximately five dollars at an auto parts store. If the battery is sealed, then the correct procedure to test it is to measure the battery's voltage with a good quality digital DC voltmeter with an accuracy of .5% or better. Voltages are shown for both 12 volt and 6 volt batteries.

(For a printable GIF of this table, Click HERE.)

Open Circuit Battery Voltage	Approximate State-of-charge	Average Cell Specific Gravity
12.70 / 6.35	100%	1.265+
12.45 / 6.23	75%	1.225
12.24 / 6.12	50%	1.190
12.06 / 6.03	25%	1.155
11.89 / 5.95	0%	1.120

Check both the specific gravity in each cell with a external hydrometer AND the battery terminal voltage with a digital voltmeter without the engine or converter/charger running. If the state-of-charge is BELOW 75% using either the specific gravity or voltage test then the battery needs to be recharged BEFORE proceeding. Replace the battery, if one or more of the following conditions occur:

- If there is a .050 or more difference in the specific gravity reading between the highest and lowest cell, you have a weak or dead cell(s),
- If the battery will not recharge to a 75% or more state-of-charge level.
- If digital voltmeter connected to the battery terminals indicates 0 volts, you have an open cell, or if the digital voltmeter indicates 10.45 to 10.65 volts (5.2 to 5.35 volts for a 6 volt battery), you have a shorted cell. [A shorted cell is caused by plates touching, sediment build-up or "treeing" between plates.

- **Winter Storage**

  Most RVs used for recreation are stored for long periods of time in the winter months. This storage can be very hard on your batteries if you don't take care of them. Batteries in storage self-discharge over time. This is a natural phenomenon and will cause your batteries to slowly go flat. Deep discharges drastically shorten your batteries life. Extremely cold temperatures can cause your batteries to freeze if they aren't adequately charged. A battery close to fully charged is far more resistant to freezing than a partially charged battery. Freezing will normally kill a flooded cell battery dead. Some of the gell batteries and most of the AGM type batteries are more resistant to damage from freezing, but it's better to prevent it. To avoid all this potential mayhem, some charging current will have to be applied to the batteries periodically during the storage period.

  To keep your battery safe through the winter storage period, consider removing the batteries and storing then in a warmer place, like a garage. Check the voltage once a month and do an overnight recharge if the voltage falls to the 80% state-of-charge point. (see charts above). If removing the batteries just isn't possible, then there are several things that you must do when the rig is put into storage.

  1. Ensure that ALL electrical loads are disconnected from your house batteries. There are lots of things in your RV that may put a tiny load on your batteries even though everything is "off". Most stereo receivers, electronically controlled refrigerators and smoke, CO2 and Propane detectors all are tiny drains on the batteries. Even if the current draw is only a few milliamps, over time these "phantom loads" will run your batteries flat! Best bet is to identify which 12 volt fuses protect these units and remove them. It is a real good idea to check at the battery with an ammeter to ensure that there is no current drain.
  2. Provide for some sort of charging to offset the batteries tendency to self-discharge. This can be provided by a small solar panel or trickle charger, or the converter or 3 stage charger in your RV. It is best to let the batteries discharge slightly over a few weeks or a month and then do a full recharge overnight. Trickle chargers and unregulated solar panels can slowly boil off electrolyte, or worse, fail to maintain the charge, allowing your batteries to become deeply discharged. If your RV has a standard converter, **do not** leave it plugged in constantly to keep your batteries up! That converter will boil your batteries **DRY** in a big hurry! If you must leave your RV plugged into A/C power over the storage period, make sure to either unplug the converter or switch it off at the breaker. It's far better to run the converter overnight every

3 or 4 weeks or so as needed to charge the batteries. Another possibility would be to put the converter or the whole RV on a simple plug in timer and set it to be "on" for about 1 hour a day. If you have a smart 3 stage charger, it may be safe to leave it plugged in at all times, buy I would pay very close attention to the electrolyte level in the batteries just in case. Boiling a battery down to where the plates are exposed to air will cause permanent damage to the battery. Don't let this happen to you!

3. Check on the batteries from time to time during the storage period. Stop by at least once a month and check battery voltage and electrolyte levels. Don't walk away from your RV batteries in November and expect them to still be ready to go in May. Folks that adopt the "Out of sight, out of mind" approach to battery maintenance are usually the ones buying a new set of batteries at the start of every camping season!

- **The bottom line....**
  - Pay attention to safety when working with or near batteries.
  - Buy only good quality **Deep Cycle** batteries for your RV. Golf cart batteries offer excellent capacity and lifespan at a reasonable cost.
  - Keep up with battery maintenance... check electrolyte levels regularly and pay attention to charging and discharging protocols to increase lifespan.
  - Invest in a good digital voltmeter and use it.
  - Consider replacing that cheesy old converter in your rig with a better quality 3 stage charger.
  - Take care of your batteries during extended storage periods.

- **Battery manufacturers**

  Here is a list of links to battery manufacturers home pages for your convenience. Many of these pages contain battery specifications, application charts and technical data. Enjoy!
  - **Lifeline Batteries Inc.**
  - **AC Delco**

- Trojan Batteries
- Interstate Batteries of America
- Optima Batteries Inc.
- GNB Technologies Inc.

OK, folks... that takes care of part 1 of the 12 volt Side of Life. Hope you found it helpful! Part 2 deals with Inverters, Solar systems, Monitoring, Wiring, Lighting and some great do it yourself projects for your RV.

Continue on to Part 2.....

This page last updated on March 3, 2002