
Lead battery charging - 12 Volt

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How To Maintain Batteries

THE BASICS ON BATTERIES

*Important Items Highlighted/Colored

First things first. A 12-volt battery is not a 12-volt battery. Twelve volts is just a nominal, convenient term used to distinguish one battery from another. A fully-charged 12-volt battery, allowed to “rest” for a few hours (or days) with no load being drawn from it (or charge going to it), will balance out its charge and measure about 12.6 volts between terminals.

When a battery reads only 12 volts under the above conditions, it's almost fully depleted. Actually, if a battery's resting voltage is only 12.0 to 12.1 it means only 20 to 25% of its useful energy remains. It's either a goner or it has been deep cycled, and a battery can only be deep-cycled a limited number of times before it is indeed dead.

12-volt batteries supply useful energy only through a limited range — from over 14 volts (when fully charged and unrested) down to 10.5 volts in use/under load (when lights dim, pumps groan and TV pictures get small). No 12-volt battery will remain at over 14 volts for more than seconds unless it's being charged. The lowest limit is 10.5 volts (used in testing) and obviously unsatisfactory in practical use. Experienced RVers try to use no more than 20% to 50% of the energy available in a battery before recharging. That means they never let resting voltage get below 12.5. They never use more than 50% before recharging (resting volts of 12.3) except in an emergency. They know that, if resting voltage ever reaches 12.1, they have deep-discharged one cycle and that a battery is good for only so many cycles (from as low as 20 in an automotive battery to 180 in a golf cart battery, with the typical RV/marine battery good for no more than 30).

Watts = Volts x Amps example: $60W = 12V \times A$ and $60 \div 12 = 5$ amps

BATTERY CHARGING VOLTAGE

Charging voltage is different. Some more basics: If you read articles on how electricity flows, you see comparisons as to how water flows. This is okay up to a point, but water also flows by gravity. Electricity doesn't, it has to be “pushed” (just as water has to sometimes be pumped).

You have to have more “juice” at one end of a wire than you need at the output or electricity won't flow. The wire you pump electricity through and the connections in the lines resist the flow. You have to overpower it. Similarly, batteries have an inherent resistance to take a charge because of their chemical makeup. You have to force more electricity into a battery than it would like to accept or it won't be fully charged. To charge a standard 12-volt battery, you have to bring it up to above 14 volts (amount varies with the type of battery).

When checking the batteries, (at rest) use these “Voltage Landmarks”.

12.6 volts = 100%

12.5 volts = 70%

12.3 volts = 50%

11.4 volts = 20%

The typical wet-cell battery (lead plates in a mixture of sulfuric acid and water) needs to be charged up to about 14.+ volts in order to adequately distribute those funny little things called electrons through the plates. Once that's done, the battery can rest. As it does, the electrons distribute themselves and eventually balance out at 12.6 volts (more or less, depending on the type battery and its condition). This is your starting point.

MORE AMPS AND VOLTS

As mentioned earlier, you should only draw a battery down to about 12.3 volts before recharging. Obviously, there's more to it than that. Amperes are the measure of actual power available. They're usually converted to amp(ere) hours (AH). Think of it as the amount of (nominal) 12-volt power you can draw out of a battery for a certain amount of time. It's not just three-tenths of a volt. It's 12 (nominal) volts for a certain amount of time. The three-tenths stuff is nothing more than a difference in measurement — like the difference between three-fourths of a tank of gas and a half tank.

Look at voltage as two things: First, a force that pushes electrons — Second, as a handy measurement.

Look at amperes as two things: First, a quantity of energy (like you would a gallon of gas) — Second, as a handy measurement. From a (nominal again, don't forget) 12-volt tub of energy, you can extract just so many amperes of power.

Keep in mind that the laws of physics prevent you from getting more out of something than you put into it! Keep in mind that waste (those wires, battery contents and such) prevents you from taking out as much as you put in. Keep in mind that you're going to have to put in about 10% more electrical power than you use (high school physics). A battery bank is like a "money" bank or checking account — if you repeatedly take more out than you put in, you'll eventually be in trouble.

MORE ON BATTERY CHARGING

Not all batteries are the same. Standard wet-cell batteries can be charged to 14.+ volts (usually 14.3 but depends on the manufacturer). Gel-cell batteries and other sealed batteries should never be charged to more than about 14.1 volts (again, may vary depending on manufacturer). And these figures only pertain when the charger will be disconnected as those levels are reached (as with a generator, solar system, portable charger, or engine alternator). As the volts drop (usually down to about 12.6 to 13.3), charging begins again, either manually or through an automatic regulator. Note also: The maximum charging voltage quoted for gels by the manufacturer is as a sustained voltage, not an intermittent one. That means brief over-voltages before a regulator shuts off are OK.

Sustained charging, where the batteries are "floated" at a constant charge (as in the RV converter or with an automatic portable charger) should not be done at more than 13.8 volts (and 13.65 makes batteries last longer). It's supposed to keep the batteries "up" to a reasonable level without undercharging or overcharging them (the assumption being you'll "top them off" by driving). Unfortunately, many cheap chargers and RV converters don't regulate very well.

Overcharging destroys batteries quickly. Undercharging destroys batteries too, but more subtly as the battery stratifies and will no longer maintain a charge. In effect, the 100 amp/hour RV battery becomes a 10 amp/hour battery after consistent undercharge. It will read full voltage, but as soon as a small load is placed on it, it drops to nothing. RVers who remain plugged into commercial power for long periods often never know this has happened until they unplug, because the converter's transformer also supplies power directly to the RV circuits while it's charging the battery — or trying to.

BATTERY EQUALIZING

Sometimes an equalizing charge can correct the above situation. BUT, don't ever try to equalize a really sealed wet battery or gel-celled or AGM battery! You've got to be really careful when doing this! The battery is going to "gas" (bubbles in the cells, hydrogen gas escaping). It shouldn't be violent, spewing acid all over the place, just gentle to rapid bubbling but it requires caution. It's usually done by hooking up a manual charger, then bringing the voltage up to 14.1 or 14.3 and, instead of stopping as usual, keeping it there, at about a 5-amp charge, for three to six hours (until voltage reaches 14.5 to 15). Do this with the caps off of a standard battery so you can see what's going on. About three hours is usually normal for one of these equalizing charges.

Follow safety precautions, use safety goggles, plenty of ventilation, etc.

Some battery people recommend equalizing in this manner every three months (or after 5 deep cycles). I think the wear and tear on a 12V battery from equalizing this often does more damage than it's worth.

Batteries held at 13.8 or so for long periods get lazy and like it there. They need some "equalizing" also. Not as drastic as above, fortunately. If you drive occasionally, your engine alternator should do it (assuming the regulator is set

properly). So will a solar electric system or a good, well-regulated independent battery charger. If nothing else, use the manual charger once in a while when parked and plugged in, but just bring volts up to 14.+ (whatever's appropriate) and stop there.

Golf Cart Battery

Six volt heavy-duty batteries (like golf carts, etc.) differ. Their heavy plates and other construction features allow periodic equalizing. I recommend the same 5 amp charge rate, for three to six hours (until voltage reaches a maximum of 16.5) every six months or so. It varies, with some people doing it monthly (which might mean another problem).

BATTERY CHARGE/DISCHARGE RATE

You'll see references in battery books to the proper charge rate. C/10, C/20, etc. Sometimes it can be confusing. What you need to know is that it means the "time" it takes to fully charge a "dead" battery at a certain amp rate. For example: A 105AH battery will fully recharge (from dead) in about 10 hours at about 10 amps of charge (C/10) or about 20 hours at 5 amps of charge (C/20). Faster charge rates, like C/5 or C/8 shouldn't be used with most batteries because the high amperage required for such a fast charge damages the battery. C/5 on a dead 105 AH battery requires pounding in over twenty amps. (This is sufficient reason to stay away from fast-chargers in service stations where a gigantic amount of amps are pummeling your battery when they "charge" (destroy) it in 20 minutes. And when you buy a battery off the shelf, don't let the guy "put it on a charger for just a few minutes" or it will be damaged before you ever use it.

BATTERY TROUBLESHOOTING AND BATTERY TESTING

Don't just replace batteries and keep on trucking! Find out what went wrong first. Is the converter working? Voltage too high? Too low? Is it connected to the battery? Fuse blown? Wire broken? Contacts cruddy? Kill switch on motor home on or off (whichever is appropriate — and the wrong position a common fault among motor homers)? How many times have you deep-cycled? Short in the system? Been hooked up a long time? Automotive regulator/alternator OK? (More later.)

Measuring, metering, testing and troubleshooting require only a few tools and basic knowledge. Much of it is common sense, requiring no tools. Do not ever depend on the red/yellow/green idiot meter installed in most RV's. Get a digital meter. You need a digital meter to accurately read battery voltage to tenths of a volt. You should have an Analog (needle face) meter also. You can't tell the difference between battery voltages with an analog with great accuracy, but they are better in some ways (because it's easier to see rapid changes) than digital meters for reading fluctuations. (Much more later.)

Get a 12-volt troubleshooting light/test lamp from any auto store cheap or make your own. (Meters will indicate voltage even if there's only one strand left in a wire. Test lamps won't light if there's not enough wire to carry the load.)

Get a decent hydrometer if you have wet-cell batteries and can remove the caps. Don't get a cheapie with colored, floating balls. Learn how to read a hydrometer.

Battery Testing

Can be done in more than one way: The most accurate method of measurement is using a hydrometer to measure specific gravity and using a D.C. voltmeter to get the battery voltage.

A quality load tester may be a good purchase if you need to test sealed 12 volt batteries.

For any of these methods, you must first fully charge the battery and then remove the surface charge. If the battery has been sitting at least several hours (I prefer at least 12 hours) you may begin testing. To remove surface charge the battery must be discharged for several minutes. Using a headlight (high beam) will do the trick. After turning off the light you are ready to test the battery.

State of Charge Specific Gravity Voltage

12V
6V

100%
1.265
12.7
6.3

75%
1.225
12.4
6.2

50%
1.190
12.2
6.1

25%
1.155
12.0
6.0

Discharged
1.120
11.9
6.0

Specific Gravity: Full charge SG will run from about 1.260 in an auto battery to about 1.275 in a golf cart. High SG (more acid) allows more juice (current) to be drawn—but only up to a point; then the battery deteriorates—fast. Golf cart plates are made to handle this, RV/Marine somewhat, automotive not at all. Don't try to get more AH by adding acid (or vinegar instead of distilled water), the battery will just die sooner.

MORE ON SPECIFIC GRAVITY—and checking resting voltage

If you have standard batteries, get a good hydrometer (not one with colored floating balls in it). It must have a tube inside with SG increments clearly marked and a built in thermometer with a temperature correction chart. It's unlikely that a new battery, even freshly charged, will give more than 80% of its rated output. You'll get more after it's been used and recharged a few times—unless it's faulty. Check SG anyway to establish a “baseline” reading.

Look especially for differences between cells. A variation of .050 between any means a possible problem. This is after it's charged and bubbled a bit to mix chemicals thoroughly. If it's a new battery and this happens, take it back. If old, plan on replacing it soon. It probably has a stratified/shorted cell. Initially, there's no need in checking SG until a battery reaches about 70% of full charge and is bubbling/gassing slightly (not boiling like a coffee pot). Then, take readings once each hour and write them down. When three successive readings are alike, the battery is as charged as it will get. Record readings for each cell and battery. Disconnect battery from any charge or load and leave it overnight (24 hours is better). Check SG again. Readings may be a bit lower, but should be consistent. Record these as your new baseline: your normal, full charge, resting values.

Do this again after two weeks or a month of use. Readings may be slightly higher, but again, should be consistent. If the batteries have been constantly overcharged or undercharged, it will show up here. You should have checked that your battery charger was set properly before starting all this, but if you get abnormal readings check that your charger

is regulating properly (see later). If you have to add water this soon, you are almost definitely overcharging. Once you've done the above tests, you shouldn't have to do it more than twice a year unless you detect a problem. You should check water level about once a month. Ideally, you shouldn't have to add water more than two to four times a year. More than that probably indicates overcharging.

Using a Hydrometer Without Making a Mess

Stick it in a cell until it just rests on top of the plates. Squirt in and out a few times—gently, don't splatter. Then fill until the inner tube floats. Too little and it will rest on bottom of hydrometer. Too much and it will hit the top. In either case, you'll get false readings. Don't remove the thing from the cell to read it, you'll just drip acid all over. Take your reading and write it down. Read at the fluid level, not at the slight curvature where the fluid touches the inner tube. (Before moving to the next cell, don't forget to squirt the acid back in.) Note temperature on thermometer and correct reading as indicated. Note, again, that all readings for a battery should be within .050 of each other. Keep in mind you might have a cheap or faulty hydrometer. El cheapos have a paper SG scale in the tube that slips up and down.

Load testing is yet another way of testing a battery. Load test removes amps from a battery much like starting an engine would. A load tester can be purchased at most auto parts stores. Some battery companies label their battery with the amp load for testing. This number is usually 1/2 of the CCA rating. For instance, a 500CCA battery would load test at 250 amps for 15 seconds. A load test can only be performed if the battery is near or at full charge.

Hydrometer readings should not vary more than .05 differences between cells.

Digital Voltmeters should read as the voltage is shown in this document. The sealed AGM and Gel-Cell battery voltage (full charged) will be slightly higher in the 12.8 to 12.9 ranges. If you have voltage readings in the 10.5 volts range on a charged battery, that typically indicates a shorted cell.

If you have a maintenance free wet cell, the only ways to test are voltmeter and load test. Any of the maintenance free type batteries that have a built in hydrometer (black/green window) will tell you the condition of 1 cell of 6. You may get a good reading from 1 cell but have a problem with other cells in the battery.

MAINTENANCE

Maintenance is all-important. Crud on top of a battery provides a path between poles. It's a "short." One most people never notice, but it uses energy constantly. You don't need to slop baking soda all over. Often just a spray 'n wipe with household cleaner is all that's needed.

Corrosion will build up. Some-times you can't even see it. Take contacts apart and clean them. (Now is when you might use baking soda, but don't let it get in the cells.) Done once or twice a year, it's fast and easy. Before putting things back together, coat all surfaces (thinly) with silicone dielectric grease. That's before, not after. You won't accomplish a thing by smearing grease on top of corrosion. Never use red battery spray. It just makes things worse. The red/green felt, noncorrosive washers are okay. Label or color-code cable and wire ends. Make a diagram. If you don't, you'll just hook things up wrong.

MORE DETAILS ON BATTERIES (MOSTLY GEL CELLS and AGM)

Much of the same material applies: All batteries need to be maintained. All batteries need to be kept charged — but not overcharged or undercharged. All need clean connections and good, stout cable and wire of the proper size. No battery should be routinely deep-cycled. Of most importance, charging needs to be well regulated.

And here's where the difference between gels, AGMs and regular, wet-cell batteries starts to show up seriously.

Wet cell (flooded) batteries: Suspended plates, usually with some form of separators (so plates don't touch each other) are immersed in liquid electrolyte. These may be charged, just as a starter battery, which makes things a lot simpler.

Gel batteries: Plates are suspended in a thick gelled electrolyte that insures stability and eliminates voids or "air pockets" at the plates. The best gels are those by "East Penn Mfg." (under "SeaGel," Prevailer" and other labels — but the East Penn name will appear somewhere). Competitors are lite weights. Gels are seldom charged to more than 14.1 volts initial (bulk) charge and 13.8 (13.65 is better) as a "float" charge (see later).

AGM (Absorbed Glass Mat) batteries: A dense fiber matting between the plates and a liquid electrolyte provide similar features to gel batteries but are much more rugged since they were designed for use in aircraft and rough

terrain vehicles. The best AGMs are those made by "Concorde" (usually under the "Lifeline" label but Concorde will appear somewhere). AGMs (like gels) are very sensitive to overcharge. 14.38 volts is recommended for the initial (bulk) charge and 13.38 as a "float" charge.

Pros and Cons:

Standard, old-timey flooded batteries are cheap (initially). They'll do the job (golf carts or similar better than RV/Marine stuff). See remarks elsewhere. They will vent gas and fluid, but it can be replenished with distilled water. They require a lot of care.

Gels and AGMs can do a better job and last longer, BUT also require special care. They're rather expensive initially (but my six gels are in their tenth year, as good as new, and the cost nets out to less than standard batteries). However, they are very carefully charged and that requires an expensive charger/regulator. Gels and AGMs don't need a lot of maintenance and cleaning (other than a quick spray and wipe from a household cleaner) UNLESS you do something stupid and overcharge them. They won't spill acid, are very shock resistant, don't pass gas (pun intended) unless seriously overcharged, have a VERY low self-discharge rate (nice when the RV is in storage) and have a very long cycle life.

I've used golf cart batteries, regular batteries and gels. As I'll repeat with more detail elsewhere, golf carts and similar batteries are, all things considered, the best solution. Were I to have to replace my batteries today (they're in the living compartment in a small RV), I'd go with AGM. In a bigger RV, I'd go with golf cart or fork lift batteries.

You should never charge a gel battery to more than 14.1 volts (or to more than the voltage specified by the manufacturer) before the regulator shuts off the charger except for very brief periods. Then, as a battery is "floated" (kept on the charger with a charge applied to keep it up to a reasonable level), it should never exceed 13.8 volts (better, for long life is a maximum of 13.65 volts). Again, though, you don't float the battery permanently. You occasionally bring it up to 14.+ (this is EZ with a solar regulator or better quality battery charger that will perform regulating tasks frequently and automatically. (more later.) AGMs are charged similarly, just with different voltages.

Actually, you'd be foolish to keep (float) any battery at a sustained charge of over 14 volts. You'd just wear it out prematurely and it would be spewing acid all the time, making a mess. But with a regular, wet-cell battery with removable caps, you can add water and clean up the corrosion. With a gel, or any other (really) sealed battery, you can't add water. All you can do is watch the battery deteriorate.

Gel batteries and AGMs do have caps, but don't ever try to remove them. First, you'll violate the warranty. Second, you'll contaminate the inside. When it dies early, the dealer/factory will know you did this and will void the warranty. Also, if you overcharge a gel or AGM battery, the factory can detect that, too. Again, no more warranty.

TEMPERATURE

Temperature is important when charging any kind of batteries. A really hot battery (EZ to achieve if they're sitting out in a cheap, plastic box) will overcharge well before the voltages listed earlier. Keeping batteries "indoors" helps keep them at about an ideal temperature (of about 68 to 77°F). Actually, high temperature only becomes a real problem when the battery is being "floated." A 13.8 volt float can easily become a 14+ a-whole-bunch float at 90°. Temp can also be a winter problem as batteries try to freeze and their amp hour capacity is reduced by over 30%.

MORE ON REGULATING CHARGE

There are only a few RV converter/combo battery chargers that are worth having. Most do an absolutely lousy job and you haven't the faintest idea what wild voltage (or lack of) is going to your batteries. Some converter/chargers do work. Check yours no matter what kind of battery you use. With the thing operating, and the battery reasonably-well charged, and not much more load on the battery than the TV antenna amplifier and reefer brain (RV reefers with a circuit board use 12 volts all the time, just to operate the board), put a digital volt meter across the "house" battery terminals. Leave it there awhile and see if it's holding the batteries to around 13.8 volts. (Or is it charging them up to something ridiculous?) (Or is it charging at all?) Some, even fewer, RVs use a separate battery charger (not as part of a converter). Generally, these are pretty good (and expensive). But check them the same way. It's not at all uncommon to find stock RV battery chargers floating batteries at 14.3 volts or higher. The best chargers regulate in two, three or four stages. First, anytime there's sufficient demand, they full charge to 14.+ volts (adjustable by you). Second, they revert to a "float" charge of about 13.8 (which in good chargers is adjustable again). Some have a third, "equalizing" stage, automatic or manual, that should also be adjustable. (There are some four-stage chargers also.)

If you want to use gel or AGM batteries, you must have a good, reliable, user-adjustable regulator and charger. The

best way to charge batteries is with a solar electric system. (Again, check first and last with "RV Solar Electric" above.) A solar system (if it has a user-adjustable regulator) will let you set the charge cut-off at desired volts. Usually, anytime the solar system achieves that, it will cut off and drop to about 13.1 volts before resuming (some solar regs will back off to a float voltage). This gives the batteries a "rest" and keeps them from overcharging. (And, of course, at night, solar systems don't do anything, so there's a good rest, too.) For a backup, you can use a generator or commercial power. Make sure your generator (if it has a direct DC 12 volt charging outlet) is set to regulate at proper volts! If it just charges through your converter, you'll have checked that above, but recheck it with the generator running. Do the same with an independent charger. Many others are available.

Deep Cycling

Let's consider something here: One does not deep cycle a battery daily as a matter of course. If one did, then the maximum life of any battery would equal the available number of cycles and no battery would last more than 6 to 9 months. Ideally, what you need is a battery (batteries) that will provide the power you require without being cycled (depleted from resting full charge) by more than 20 to 50% before being recharged. (If you have a 100AH battery and take no more than 20AH from it before recharging, it might last longer than you will.) Unfortunately, this isn't realistic, but you can take up to 50% from a battery before recharging and still get long life. Simple arithmetic—how many AH used versus how many AH available will tell you how many batteries are needed. Keep in mind that you shouldn't expect but 80% of the manufacturer's rating. So a 105AH battery is really about 84AH. MAX! No battery will give you its rated output in real life! They're rated down to an end point of 10.5 volts. By then, lights get dim and TV picture small. A Specific Gravity of about 1.200 or a voltage of 12.25 to 12.3 means the battery is about 50% discharged. By the time it's down to 11.8 or 12 volts, it's almost dead.

AMP Hours and Battery Capacity

What are "Amp Hours"? Amp hours is the amount of current in "Amps" times the number of hours it can deliver that current.

Example: A 100 amp-hour battery can deliver 10 amps for 10 hours or 20 amps for 5 hours.

One amp for 100 hours, or any combination, should allow you to rate batteries, but it doesn't work like that. (It's a logarithmic, not a linear, progression.) Further, capacity, in AH, depends on several things: size, amount/type electrolyte, plate thickness, etc. You don't want to investigate all that crap. Of key interest to us are:

Rate of Discharge: Generally 20 hours for automotive, 6 for golf cart and 8 for RV/Marine. A 180AH golf cart will, technically, give you 30 amps for its rated 6 hours, but it will not give 60 amps for three hours. (Has to do with things like heat at this higher rate due to extreme chemical action demanded—stuff you don't want to fool with.) It will give one amp for about 105 hours, though, which is nice to know. Don't just read AH. Read the charts when comparing batteries.

Specific Gravity: Full charge SG will run from about 1.260 in an auto battery to about 1.275 in a golf cart. High SG (more acid) allows more juice (current) to be drawn—but only up to a point; then the battery deteriorates—fast. Golf cart plates are made to handle this, RV/Marine somewhat, automotive not at all. Don't try to get more AH by adding acid (or vinegar instead of distilled water), the battery will just die sooner.

Temperature: Batteries are made to perform best at 77°F. At higher temps, they put out more, but die sooner. At lower temps, they put out less, but last longer (unless you let them freeze).

CABLES AND CONNECTIONS

Tying the system together is important. No point spending a lot of money on batteries and chargers and wiring it up with skimpy junk. Large battery cables can be purchased from San Diego Battery Wholesale. Custom-made cable to your lengths with terminals that match your vehicle is also available.

METERING BATTERIES

If you have maintenance free (maintenance prohibitive) batteries, you can't have fun with a hydrometer. Even if you can use a hydrometer, you don't need to (or want to) do it more than a couple of times a year. Use the chart (see later) to keep an accurate check on state of charge. When taking SG readings, measure voltage at the same time. Keep in mind that if a battery is charging, voltage will read about ½ to 1 volt higher than actual. Note that chart voltages (later) are as little as .05 apart. You can't read that accurately on an analog (dial/needle-faced) meter. You need a digital meter. You don't need to spend over \$200 for a professional model. See ads in electronics magazines for reasonably priced meters. You need a 3½ digit" meter (reads to two decimal places) and get one with at least a 10 amp current measure (20 is better). At present, the best deal is a Metex brand #M3800 3½ digit at 20 amp capacity for \$40 from:

JAMECO. (See Sources.) All RVers need one of these anyway.

When checking the batteries, (at rest) use these “Voltage Landmarks”.

12.6 volts = 100%

12.5 volts = 70%

12.3 volts = 50%

11.4 volts = 20%

MORE ON UNDERCHARGE AND OVERCHARGE

“Under” results in stratification. “Over” simply eats the plates. Use a regulator to prevent overcharge. When you think a battery is charged, too high a SG means over. Too low means under. Compare with an accurate voltage check. You should only need to add water a few times a year. More means battery’s gassing too much. You can’t tell by feeling the heat of the battery case any more (better plastics). You must put about 10% more energy into a battery than you take out (more high school physics—anytime energy is transformed, there must be some loss). An “old” battery can require more. Compare how much you’re putting in versus what you take out and size your system accordingly.

CONNECTING BATTERIES IN PARALLEL, SERIES and SERIES-PARALLEL

This is really simple, but it’s amazing how many RVers screw it all up!

In series, volts increase; amps remain the same.

In parallel, amps increase; volts remain the same.

In Parallel: you connect the (+) of one 12vbat to the (+) of the other. Connect (-) of one to the (-) of the other. You will then still have a 12volt bat, but with greater amp hour capacity. This is now an ordinary 12V bat, except that instead of being in one “box,” it is in two boxes.

In Series: If you were to hook two 12 volt batteries in series, you’d have 24 volts. Clearly not the thing to do unless you have a bus conversion or custom rig that uses 24Volts. However, many RVers use 6 volt (usually golf cart) batteries. E.G., Two 105AH 6v in series would still = about 105AH but @ a nominal 12V.

Wiring in Series:

To visualize it easier. Start with a simple block diagram. Two 6V batteries.

On left bat, place (-) at left end, place (+) on right end.

On right bat, place (-) on left end, place (+) on right end.

Draw a line from (+) on left bat to adjacent (-) on right bat.

This is now an ordinary 12V bat, except that instead of being in one “box” with cells all connected in series on the interior, it is in two boxes joined with a cable. It’s still a single 12 volt bat, electrically, so **START THINKING OF IT THIS WAY** and don’t confuse yourself by thinking of it as bat 1 and bat 2.

At this point, you’ve got two unused bat posts — just like an ordinary 12 volt bat; one neg that goes to chassis ground and one pos that goes to normal 12V isolator/supply/etc.

Series/Parallel:

Just repeat the series step above with two more 6 volt bats and you end up with two 12V bats. Think of it this way instead of as four 6V bats! You now have two (-) unused posts. Connect them together (just as you would when connecting two ordinary 12V bats in parallel). Repeat for the two unused (+) posts.

It’s really quite simple. The problem many people have is in thinking that this is very complicated. It’s not.

The only time you think of the bats as four 6V bats is when you disconnect them for maintenance and cleaning. And then, only to make absolutely certain that you don’t screw up when putting them back together.

Toward this end, it’s essential that you clearly label posts and cable ends!

% Of Charge

Standard Battery
Typical Specific Gravity
(After Temperature Correction)
Standard Battery
Equivalent
Resting Volts
Gel-Cell Battery
Equivalent
Resting Volts

100%
1.260 (auto) to 1.280 (industrial)
12.60-12.75
12.90-13.00

95%
1.255
12.60-12.70
12.80

90%
1.250 (Resting S.G. for standard RV battery.)
12.60-12.65
12.70

85%
1.245 (Same as above. No point being too picky.)
12.60

80%
1.235-1.240 (We try not to discharge below this point.)
12.50-12.55
12.60

75%
1.225-1.230 (1.230=minimum SG for a charged battery.)
12.50

70%
1.220 (Anything below 1.220 is "poorly" charged.)
12.45
12.50

65%
1.215
12.40

60%

1.205

12.35

12.40

55%

1.200

12.30

50%

1.190-1.195 (Try to never discharge below this point.)

12.25

12.35

45%

1.185

12.20

40%

1.180

12.15-12.20

12.25

25%

1.160-1.170 (Dangerously low; battery being damaged.)

12.10-12.15

20%

1.150 (Cells die soon at this point. Bye-bye battery.)

11.80-12.00

12.15

TROUBLESHOOTING

House Battery: The intent here is to determine if the battery itself is good, and, in its role as a “house” battery, how you can test it, the house wiring and charging circuit.

Situation: You're charging the battery from any one of several sources. Everything has been working fine; but for no apparent reason and all of a sudden, there's no electricity. Don't just start taking everything apart! Look around for the obvious. Is the battery still there? Is everything in one piece? (A nearby lightning strike can blow the top off.) Are the cables connected? I once spent an hour roaming around with a volt meter only to find I'd simply left the negative cable off.

Steps:

Connect a volt meter across the battery. It should read some, reasonable voltage even if well discharged (unless it's dead). If voltage is adequate, and assuming things are normal, try moving/twisting the main cable clamps at the

battery. Often, even on a clean-appearing battery, a thin film of corrosion builds up between post and connector (that you can't see). While the corrosion builds up very gradually, its effect can happen suddenly.

Next, especially if the connections are cruddy, place the tip of an upright, flat-bladed screwdriver on top at the circular junction of post and clamp and give it a good sock with your fist (not a hammer).

Do the same with the other post. If bad connections are the problem, the above should allow at least some electricity to flow—enough to indicate the problem. If the above helps at all, take things apart and clean them.

If the above doesn't help, first disconnect the charging source then disconnect the battery (you might as well go ahead and remove it). Before you start phiddling with the battery, attach a pair of jumper cables from a known, good battery to the RV cables.

Attach the (+) cable first. If you don't let the loose end touch something, there should be no sparks because there's no place for electricity to go (yet).

Then attach the (-) cable to the "good" battery. (Again, there should be no sparks if you don't screw up.)

Finally, attach the last (-) end to the RV cable (If the bad battery was removed, sparks at this final connection shouldn't hurt anything. This seems like a roundabout way to do all this but there's a reason for it.

If there's now electricity in your house, you know you had a discharged battery. Perhaps a bad battery, but not necessarily. Again, before you start phiddling with the "bad" battery, you need to check the charging system. The idea here is find out why the battery discharged.

Run a load (lamp or whatever) to remove the surface charge from your "good" temporary battery. Depending on what kind of battery charger you have, you may need to run the battery down to about 13V or less to get the regulator to allow charging to resume. Keep measuring voltage. When charging resumes, it will increase.

If the voltage doesn't increase, it's possible that your charging source (converter, generator, solar system) isn't working or the flow is interrupted.

Make the dumb checks first:

Is the converter working? Is the "kill" switch on or off on some motor homes? It's unlikely, because then you should have had a gradual loss, not a sudden one. It is possible though.

And it's possible you have a bad battery AND a bad charging system. RV converters with built-in battery chargers can really confuse you. There are two outputs to these things: One furnishes 12V direct from the transformer to most house circuits. The other goes from battery charger portion to battery. If you've been plugged into commercial power, the main transformer may have been running everything while the battery charger was not working. Also, the "kill" switch may have been off or fuse from charger blown. (Check the dumb things first.)

Put a volt meter at the battery end while you're doing it. Quite often, a little manipulating will clear things right up. If not, go back to the source of the charging system with your volt meter. Is there power at the charger output? At the output to battery terminal at solar panels or solar regulator?

Again, check fuses carefully. You can't tell if a fuse is bad by looking at it, you need to measure it with a test lamp. Remember that a meter can indicate "good" if there's only a slight contact but a test lamp won't work if there's not enough to carry the load.

If this also fails, you may have to check at the charging source with no battery attached. It's easy with an RV converter, but if you use a solar system or wind generator you may not be able to (some can be severely damaged if run without a load). RTFM (Read The F***** Manual)! Our purpose in checking at the source (with or without battery connected) is to see if there's anything there.

If there's still no voltage, now starts the onerous process of checking the whole system.

Do it logically. Go all the way to the source first. Disconnect generator, solar panels, whatever, from the system. You can now measure them in operation without damaging anything (except some wind chargers). If the charger works, you know that you have two long pieces of wire (+) and (-) with a problem somewhere. Don't ignore the (-) wire. It is every bit as necessary as the (+). Reconnect charger and battery if necessary.

Go to some logical halfway point with your volt meter. One way or the other, you'll get voltage (unless you missed something at the source). Continue in this manner, roughly going halfway (each time on the dead side). Unless you screw up, you'll soon isolate the problem to just a few feet of wire. If something hasn't been left unconnected or the wire been cut, you'll usually isolate the problem to a connection or fuse.

Look at things, pull on wires to make sure they're really attached. This is where bad crimped connections show up. (I spent an hour helping someone track down a solar system this way. Every crimped terminal fell apart in my hands. He'd crimped them with normal pliers.) Look for corrosion at terminals, just as at battery cables. Remember that just

because a converter is buzzing, it doesn't mean the battery charger is working. If working with a solar system, never try to put a jumper across the solar (+) and battery (+) to bypass the regulator—you'll fry it. However, if you disconnect those wires from the regulator, then you can put them together.

All the above can be done with a volt meter or test lamp. In fact, a test lamp works better at continuity checks, because a volt meter might indicate power if only one strand of wire is still connected while a test lamp won't light if it doesn't have a circuit heavy enough for the load.

TO CHECK THE BATTERY ITSELF—MORE ON RESTING VOLTAGE

It can be checked with a hydrometer, but a battery can read OK and still be faulty. Here's a good way to check a battery. It takes time, but it's worth it:

Charge it fully, preferably with a good battery charger or an independent, manual, automotive charger (you need one anyway for emergencies). This can take awhile if it's been deep discharged (dead).

Measure voltage. It should be quite high—over 13 volts and 14.+ is better. Disconnect the charger. Leave the battery (with nothing connected to it) at least 6 hours. Overnight or 24 hours is better.

Measure voltage again. It should be 12.6 volts. If not, even if it's 12.5, it's a goner or it's going. If it reads 12.6, it still might be bad.

A commercial battery shop can check this with a variable load tester. So can you. If the battery is at least a so-called 100AH RV/Marine type, it should start most engines in decent weather. Connect a volt meter across it. If it doesn't start, jump start it. Run the engine at a nice, fast idle (1,500 to 2,000 rpm).

If the voltage rises to over 14 volts in only 4 or 5 minutes, you have a bad battery. Due to things we won't dwell on here, the AH capacity has been severely reduced (stratification, deep discharges, etc.). What you have is a battery that has about a 10AH capacity instead of 100AH. It tests OK because it has some capacity (might run a lamp a few hours), but not enough. This common problem often drives people nuts. It tests OK, it just won't last long.

The same test works on auto batteries. They test OK but won't start an engine.

BATTERY ISOLATORS

Almost everybody has one. Most people never pay attention to them. I do. And I've got mine remoted to a switch on the dash to avoid the [many] problems they can cause. Most isolators send a charge to the batteries automatically. I don't want to do that. Normally, my solar system keeps the "house" batteries charged just fine. There are times, in bad weather, when I need to boost the batteries, so when on the road I hit the switch that goes to the charge line to house batteries and the engine alternator charges them in the normal way. A cheap, voltmeter on the dash keeps me informed when to shut charging off.