AUTO BATTERY FREQUENTLY ASKED QUESTIONS

A word of caution. Batteries contain a sulfuric acid electrolyte which is a highly corrosive poison, that will produce gasses when recharged and explode if ignited. This will hurt you--BAD! 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. This FAQ assumes a six cell, 12 volt negatively grounded system found in most cars, light trucks and vans.

WHAT IS THE BOTTOM LINE?

A. At the first sign of slow starting, headlights dim at idle, gauges indicate discharge with engine running at high idle, or your battery seams to be loosing performance, test it! (See Section 4.)

B. Perform regular preventative maintenance, especially during HOT weather and before COLD weather, (See Section 3)

C. Remove surface charge before load testing and check the specific gravity in each cell and the terminal voltage, (See Section 4)

D. Keep the battery charged, but do NOT overcharge, (See Section 9)

E. Buy the freshest and largest Reserve Capacity (RC), battery that will physically fit with a Cold Cranking Amp (CCA) rating for your climate that meets or exceeds the car's Original Equipment Manufacturer's (OEM) cranking amp requirement, and (See Section 7)

F. Retest after deep discharges or jump starts for latent damage. (See Section 4)

WHY BOTHER?

Because only the rich can afford cheap batteries.....

A good quality battery will cost between $50 and $100 U.S. and, if properly maintained, it should give you an average of five years of service. The primary purpose of a car battery is to START the engine. It also is used to filter or stabilize the power and provide extra power for the ignition, lighting and other accessories when their combined load EXCEEDS the capability of the charging system, i.e., when the engine is idling. In addition, a car battery provides power to the electrical system when the charging system is not operating.

Normally a battery "ages" as the active plate material sheds (or flakes off) due to the expansion and contraction that occurs during the discharge and recharge cycles. Deep discharges, heat and vibration accelerate this "aging" process. Eventually, the sediment builds up and the can short the cell out. Another major cause of faulty batteries is sulfation. When batteries are stored discharged or for over six months, lead sulfate makes the plates very hard and dense and the battery less capable or unable to be recharged. When the active material in the plates can no longer

sustain a discharge current and the battery "dies". In a hot climate, the harshest environment for a battery, a recent JCI survey of junk batteries revealed that the AVERAGE life of a good quality car battery was 37 months. Slow cranking, especially on a cold day, is another good indication that your battery is going bad and it should be tested.

Deeply discharged batteries almost always occur at the most inopportune times, e.g., AFTER you have jump started your car, at the airport returning home from a long trip, during bad weather, late at night in a dark parking lot, or when you are late for an appointment. You can easily spend the cost of a new battery or more for an emergency jump start or tow.

Most of the "defective" batteries returned to the manufacturer are good. This suggests that most SELLERS of new batteries do not know how or take the time to properly test or recharge batteries.

HOW DO I PERFORM PREVENTATIVE MAINTENANCE?

Maintaining the correct electrolyte levels, tightening loose hold-down clamps and terminals, removing corrosion, and checking the alternator belt tension is normally the ONLY preventative maintenance required for a battery. The preventive maintenance frequency is dependent upon climate and battery type, but you should perform at least once before cold weather starts and once a month in hot weather.

If the electrolyte levels are low in non-sealed batteries, add DISTILLED water to the level indicated by the battery manufacturer or to 1/8" BELOW the bottom of the filler tube (vent wells). DO NOT OVERFILL, especially in hot climates!

HOW DO I TEST A BATTERY?

The are four simple steps to test a car battery--inspection, remove surface charge, state-of-charge test and load test. To test a battery (or to troubleshoot charging or electrical systems), you will need a digital voltmeter with .5% or better accuracy. A digital voltmeter can be purchased at an electronics store and will cost between $20 and $200 U.S. If you have a non-sealed battery, you can use a temperature compensating hydrometer which can be purchased at an auto parts store for approximately $5 U.S.

A. INSPECTION

Visually inspect for obvious problems, e.g., loose alternator belt, low electrolyte, corroded cable or terminal clamps, loose hold-down clamps or cable terminals, or a damaged case.

B. REMOVE SURFACE CHARGE

If you have just recharged you battery or driven your car, eliminate any surface charge by one of the following methods; otherwise, go to the next step:

1. **Allow the battery to sit for two to three hours,**

2. Turn the headlights on high beam for five minutes and wait five minutes, or

3. With a battery load tester, apply a load at one half the battery's CCA rating for 15 seconds and wait five minutes.

C. STATE-OF-CHARGE TEST

Using the following table, determine the battery's state-of-charge:

Open Circuit Battery Voltage	Approximate State-of-charge	Average Cell Specific Gravity
12.65+	100%	1.265+
12.45	75%	1.225
12.24	50%	1.190
12.06	25%	1.155
11.89	0%	1.120

[If the temperature of the electrolyte is below 70 degrees F (21.1 degrees C), then add .012 volts (12 millivolts) per degree below 70 degrees F to the reading.]

For non-sealed batteries, check both the specific gravity in each cell with a external hydrometer AND the battery terminal voltage with a digital voltmeter without the engine running. For sealed batteries, measuring the battery's voltage without the engine running with an accurate digital voltmeter is the only way you can determine the state-of-charge. Some batteries have a built-in hydrometer which only measures the state-of-charge in ONE of it's six cells. If the indicator is clear or light yellow, then the battery has a low electrolyte level and should be refilled before proceeding, or if sealed, the battery should be replaced.

If the state-of-charge is BELOW 75% using either the specific gravity or voltage test or the built-in hydrometer indicates "bad" (usually dark), then the battery needs to be recharged BEFORE proceeding. Replace the battery, if one or more of the following conditions occur:

1. 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),

2. If the battery will not recharge to a 75% or more state-of-charge level or if the built-in hydrometer still does not indicate "good" (usually green, which is 65% state-of-charge or better),

3. If digital voltmeter indicates 0 volts, you have an open cell, or

4. If the digital voltmeter indicates 10.45 to 10.65 volts, you have a shorted cell. [A shorted cell is caused by

plates touching, sediment build-up or "treeing" between plates.

D. LOAD TEST

If the battery's state-of-charge is at 75% or higher or has a "good" built-in hydrometer indication, then load test the battery by one of the following methods:

1. Turn the headlights on high beam for five minutes,

2. Disable the ignition and turn the engine over for 15 seconds with the starter motor,

3. With a battery load tester, apply a load equal to one half of the CCA rating of the battery for 15 seconds, or

4. With a battery load tester, apply a load equal to one half the OEM cranking amp specification for 15 seconds.

DURING the load test, the voltage on a good battery will NOT drop below 9.7 volts with the electrolyte at 80 degrees F (26.7 degrees C). [If the electrolyte is above 80 degrees F, add .1 volt for every 10 degrees above 80 until you reach 100 degrees. If below 80 degrees F, subtract .1 volt for every 10 degrees until 40 degrees.] After the load is removed, wait five minutes and the battery should "bounce back" to the 50% state-of-charge level or above. If the battery drops below minimum test voltage, does not bounce back, or will not start the engine, then you should replace it. If the battery passes this test, you should recharge it to restore it to peak performance.

HOW DO I KNOW IF MY CHARGING SYSTEM IS OK?

A car's charging system is composed of an alternator (or DC generator), a voltage regulator, battery and indicator light or gauge. While the engine is running, it's purpose is to provide power for the car's electrical load, e.g., ignition, lighting, accessories, etc., and to recharge the car's battery.

When the charging system fails, usually an indicator light will come on or the gauge will not register "good". The most common charging system failure is a loose, worn or broken alternator belt, so check it first. If OK, then with a known good battery and the engine running at 2000 RPM or more for two minutes, depending on the load and ambient temperature, the voltage should increase to between 13.0 and 15.1 volts. Most cars will measure between 14.0 and 14.5 volts on a warm day. [Most voltage regulators are temperature compensated to properly charge the battery under different environmental conditions. As the ambient temperature decreases, the charging voltage is increased to overcome the higher battery resistance. Conversely, as the ambient temperature increases, the charging voltage is reduced. Other factors affecting the charging voltage are the battery's condition, state-of-charge, electrical load and electrolyte level and purity.]

If terminal voltage is below 13.0 volts and the battery tests good after being externally recharged or if you are still having problems keeping it

charged, then have the charging system's output voltage and current and car's parasitic (key off) load tested. A loose alternator belt or bad diode will significantly reduce the alternator's current output.

If output voltage is above 15.1 volts with the ambient temperature above freezing, the battery's electrolyte level is frequently low, or you smell "rotten eggs" around the battery, then you are probably overcharging the battery and the charging system should be tested.

HOW DO I JUMP START MY CAR?

In cold weather, a good quality booster cable with four to six gauge wire is necessary to provide enough current to the disabled car to start the engine. [The smaller the wire gauge number, i.e., the larger the wire diameter, the better.] Please check the owner's manual for BOTH vehicles BEFORE attempting to jump start and follow the manufacturer's procedure because some cars should not be running during a jump start. However, starting the disabled car with the good car running can prevent having two disabled. DO NOT allow the booster cable clamps touch each other or the POSITIVE clamp to touch the frame or engine block.

A. If BELOW freezing, determine that the electrolyte is NOT frozen in the dead battery. If frozen, allow to thaw BEFORE proceeding. A discharged battery, i.e., battery voltage or 12.0 volts or less or specific gravity of 1.140 or less, will freeze at approximately 8 degrees F (-15 degrees C).

B. Without the cars touching, turn off all unnecessary accessories and lights on BOTH cars, insure there is plenty of ventilation, and put on some protective eye ware.

C. Start the car with the good battery and let it run for at least two or three minutes at fast idle to recharge it's battery BEFORE proceeding.

D. Connect the POSITIVE booster cable clamp (usually RED) to the POSITIVE terminal on the dead battery. Connect the POSITIVE booster cable clamp on the other end of the booster cable to the POSITIVE terminal on the good battery.

E. Connect the NEGATIVE booster cable clamp (usually BLACK) to the NEGITIVE terminal on the good battery and the NEGATIVE booster cable clamp on the other end to a clean, unpainted area on the engine block or frame on the disabled car AWAY from the battery.

F. Let the good car to continue to run at high idle for five minutes OR MORE to allow the dead battery to receive some recharge and to warm it's electrolyte.

G. Start the disabled car and allow to run at high idle. If the car does not start the first time, recheck the connections, wait a few minutes and try again.

H. Disconnect the booster cables in the REVERSE order, starting with the NEGITIVE clamp on the block or frame of the disabled car to minimize the possibility of an explosion.

I. As soon as possible, fully recharge and test the dead battery for latent or permanent damage as a result of the deep discharge.

WHAT DO I LOOK FOR IN BUYING A NEW BATTERY?

Battery buying strategy for use in Canada, for example, is different than hot climates that you find in Texas. In the colder climates, higher CCA ratings are more important; whereas, in a hot climate, a higher RC ratings are more important once the CCA rating has satisfied the OEM cranking amp requirement.

A. Cold Cranking Amps (CCA)

The most important consideration is sizing the battery's CCA rating to MEET OR EXCEED, depending on the climate, the car's OEM cranking requirement. [CCAs are the discharge load measured in amps that a fully charged battery at 0 degrees F (-17.8 degrees C) can deliver for 30 seconds and while maintaining the voltage above 7.2 volts. Batteries are sometimes advertised by their Cranking Performance Amps (CA) or Marine Cranking Amps (MCA) measured at 32 degrees F (0 degrees C) or Hot Cranking Amps (HCA) measured at 80 degrees F (26.7 degrees C), which are not the same as CCA. Do not be mislead by CA, MCA or HCA ratings. To convert CAs to CCAs, multiply the CAs by .8. To convert HCAs to CCAs, multiply HCAs by .69.]

In hot climates, buying batteries with double or triple the CCA ratings that exceed the OEM requirement is a WASTE of money. However, in colder climates the higher CCA rating the better, due to increased power required to crank a sluggish engine and the inefficiency of the cold battery. As batteries age, they are less capable of producing CCAs.

One of the major battery manufacturers, Exide, publishes the following table:

Available Power From Battery	Temperature degrees F	Power Required To Crank Engine
100%	80	100%
65%	32	155%
40%	0	210%
25%	-32	350%

[If more CCA capacity is required, two (or more) 12 volt batteries can be connected in parallel. Within a BCI group size, generally the battery with more CCA will have more plates because a larger surface area is required to produce the higher current.]

B. Reserve Capacity (RC)

The second most important consideration is the Reserve Capacity rating because of the effects of an increased parasitic (key off) load and in emergencies. [RC is the number of minutes a fully charged battery at 80

degrees F (26.7 degrees C) can be discharged at 25 amps until the voltage falls below 10.5 volts.] More RC is better in every case! In a hot climate, for example, if your car has a 360 OEM cranking amp requirement, then a 400 CCA rated battery with 120 minute RC with more electrolyte would be more desirable than one with 1000 CCA with 90 minutes of RC.

[If more RC is required, two six volt batteries can be connected in series or two (or more) 12 volt batteries can be connected in parallel. Within a BCI group size, generally the battery with larger RC will weigh more because it contains more lead.]

C. Type

The two most common types of CAR batteries are low maintenance (non-sealed) and maintenance free (non-sealed or sealed). [The low maintenance batteries have a lead-antimony/calcium (dual alloy or hybrid) plate formulation; whereas, the maintenance free batteries have a lead-calcium/calcium formulation.] The advantages of maintenance free batteries are less preventative maintenance, longer life, faster recharging, greater overcharge resistance, reduced terminal corrosion and longer shelf life, but are more prone to deep discharge (dead battery) failures due to increased shedding of active plate material. In hot climates, buying non-sealed batteries is recommended because a sealed battery will NOT allow you to add water when required or to test the specific gravity with an external hydrometer.

Some manufacturers introduced a third type of car battery, "dual", that combined a standard battery with switchable emergency backup cells. For about the same cost a better approach was to buy two batteries and isolate them.

In the future, you can expect to see more expensive valve regulated (gel cell and absorbent glass mat (AGM), e.g., Interstate's Extreme Performance, and Optima, batteries used. This is because car manufacturers want to extend their "bumper-to-bumper" warranty periods or as the batteries are relocated from under the hood to avoid temperature extremes. Please refer to the Deep Cycle Battery FAQ for more information on valve regulated batteries.

For off road applications in trucks, recreational vehicles (RVs), 4x4s, vans or sport utility vehicles, some manufacturer's distribute "high vibration" or RV battery versions designed to reduce the effects of moderate vibration. For excessive vibration applications, it is best to buy a commercial or AMG battery.

Car batteries are specially designed for high initial cranking amps (usually for five to 15 seconds) to start an engine; whereas, deep cycle (or marine) batteries are designed for prolonged discharges at lower amperage. A "dual marine" battery is a compromise between a car and deep cycle battery; however, a CAR battery will give you the best performance in a CAR. For RVs, a car battery is used to start the engine and a deep cycle battery is used to power the accessories.

D. Size

Manufacturers build their batteries to an internationally adopted Battery

Council International (BCI) group number (24, 26, 70, 75, etc.) specification, [which is based on the physical case size, terminal placement and terminal polarity.] The OEM battery group number is a good starting place to determine the replacement group. Within a group, the CCA and RC ratings, warranty and battery type will vary in models of the same brand or from brand to brand. Batteries are generally sold by model, so the group numbers will vary for the same price. This means that for the SAME price you can potentially buy a physically larger battery with more RC than the battery you are replacing, e.g. a 34/78 group might replace a smaller 26/70 group and give you an additional 30 minutes of RC. If you do this, be sure that the replacement battery will fit, the cables will connect to the correct terminals, and that the terminals will NOT touch the hood when closed.

BCI and the battery manufacturers publish application guides that will contain the OEM cranking amperage requirements and group number replacement recommendations by make, model and year of car, and battery size, CCA and RC specifications. Manufacturers might not build or the store might not carry all the BCI group numbers. To reduce inventory costs, dual terminal "universal" batteries that will replace several group sizes are becoming more popular and fit 75% or more of cars on the road today.

Battery manufacturers or distributors will often "private label" their batteries for large chain stores. Below is a list in alphabetical order of the largest domestic battery manufacturers/distributors in North America and my understanding of some of their brand names, trademarks and private labels.

AC Delco/Delphi (800-223-3526 or www.acdelco.com)
- **DieHard Gold (Sealed) (Contact local Sears store or www.sears.com)**
- **Double Eagle (Contact local Goodyear store)**
- **Dura Power**
- **Everstart (888-387-8278 or contact local Wal-Mart store)**
- **Freedom (Contact local Sears store or www.sears.com)**
- **Lastcell (Contact local Trac Auto store)**
- **Professional**
- **Tough One (Contact local Western Auto store or www.westernauto.com)**
- **Voyager**

East Penn (610-682-6361 or www.eastpenn-deka.com)
- **American**
- **Dominator**
- **Electro**
- **Deka**
- **Hi-Tech**
- **Inferno**
- **Pow-R-Surge**
- **Unitech**

Exide (800-782-7848 or www.exideworld.com)
- **Auto Express (Contact local Wards store)**
- **Centura (Contact local K-Mart store)**

Challenger
DieHard (non-Gold) (Contact local Sears store or www.sears.com)
Edge(Angler's, Arctic, Commander's, Cutting, Mariner's and Universal)
Heat Guard
Legend (800-538-6272 or contact local NAPA store or www.napaonline.com)
Max
Mega Cell and Mega Cycle
Motorvator (Contact local K-Mart store)
Muscle Man
NASCAR Select
Nautilas and Nautilas Gold
Power GLX (800-538-6272 or contact local NAPA store or www.napaonline.com)
Power-Tron
Prestolite (Contact local HiLo store)
Pro Start (Contact local Pep Boys store or www.pepboys.com)
Quick Start (Contact local Wards store)
Sears (Contact local store)
Sure Start (800-538-6272 or contact local NAPA store or www.napaonline.com)
Titan
Value-Life (Contact local Firestone store)
Farmland (Contact local store)
Guardian
Omni

GNB (800-242-6750 or www.gnb.com)
American
Action Pack
Champion (Contact local Sams store)
Dominator
Dunlop
High Energy
National
Omaga (800-925-6278 or contact local Wal-Mart store)
Power Breed
Scorcher
Super Crank
Switch
Voyager (Contact local Sams store)

Johnson Controls Inc. (www.jci.com)
Diehard Gold (Non-sealed) (Contact loacal Sears store or www.sears.com)
Dura-Last (Contact local Auto Zone store or www.autozone.com)
Energizer (Contact local Target or Wards store)
Equalizer (Contact local Wards store)
Eveready (800-331-9926 or contact local Costco or Wards store)
Interstate Ameriton, Mega-tron or MT-Plus (800-272-6548 or www.interstatebatteries.com)
Motorcraft Tested Tough (800-392-3673 or contact local

Ford dealer)
Power Connection

E. Freshness

Determining the "freshness" of a battery is sometimes difficult. NEVER buy a battery that is MORE than SIX months old because it is starting to sulfate. [Sulfation occurs when lead sulfate can not be converted back to charged material and is created when discharged batteries stand for a long time or from excessive water loss.] The date of manufacture is stamped on the case or printed on a sticker. It is usually a combination of alpha and numeric characters with letters for the months starting with "A" for January (generally skipping the letter "I") and digit for the year, e.g., "J6" for September, 1996. Like bread, fresher is definitely better.

F. Warranty

As with tire warranties, battery warranties are NOT necessarily indicative of the quality or cost over the life of the car. Most manufacturers will prorate warranties based on the LIST price of the bad and replacement battery, so if a battery failed half way or more through its warranty period, buying a NEW battery outright might cost you less than paying the difference under a prorated warranty. The exception to this is the free replacement warranty period. This represents the risk that the manufacturer is willing to assume. A longer free replacement warranty period is better and is usually an indication of the quality of the battery.

HOW DO I INSTALL A BATTERY?

A car battery weights between 30 and 60 pounds, so the first question is do I want to install it myself? The second question is what do I do with the old battery if not exchanged for the new one?

A. Thoroughly wash and clean the old battery, battery terminals and case or tray with water to minimize problems from acid or corrosion. Heavy corrosion can be neutralized with a mixture of baking soda and water. Also, mark the cables so you do not forget which one it is which when you reconnect.

B. 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.

C. After removing the old battery, 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. Corroded terminals or cables will significantly reduce starting capability.

D. Thinly coat the terminal and terminal clamps with a high

temperature grease or petroleum jelly (Vaseline) to prevent corrosion.

E. Place the replacement battery so that the NEGATIVE cable will connect to the NEGATIVE terminal. Reversing the polarity of the electrical system will severely damage or DESTROY it or cause the battery to explode.

F. After replacing the hold-down bracket, reconnect the cables in reverse order, i.e., attach the POSITIVE cable first and then the NEGATIVE cable last.

G. Before starting the engine, check the electrolyte levels and state-of-charge. Refill or recharge as required.

[If you want to retain your car's computer memory, security codes or radio settings, a second battery can be temporarily connected to the electrical system in parallel before disconnecting the first one. A cigarette lighter plug can used to easily connect a parallel battery.]

HOW DO I RECHARGE MY BATTERY?

In addition to the earlier cautions, some more words of caution:

A. NEVER, NEVER disconnect a battery cable from car with the engine running because the battery acts like a filter for the electrical system. Unfiltered [pulsating DC] electricity can damage expensive electrical components, e.g., computer, radio, charging system, etc.

B. Check the electrolyte level and be sure it is not frozen BEFORE recharging.

C. Do NOT add water if the electrolyte is covering the top of the plates because during the recharging process, it will warm up and expand. After recharging has been completed, RECHECK the level.

D. Reinstall the vent caps BEFORE recharging, recharge ONLY in well ventilated areas, and wear protective eye ware. NO smoking, sparks or open flames because while the battery is being recharged because they give off explosive gasses.

E. If your battery is sealed, do NOT recharge with current ABOVE 25 amps.

F. Follow the charger manufacturer's procedures for connecting and disconnecting cables and operation to minimize the possibility of an explosion, but generally you should turn the charger OFF before connecting or disconnecting cables to a battery.

G. If a battery becomes hot, or if violent gassing or spewing of electrolyte occurs, turn the charger off temporarily or reduce the charging rate.

H. Insure that in car charging with an external charger will not damage the car's electrical system with high voltages. If this is even a remote possibility, then disconnect the car's negative battery cable from the battery BEFORE connecting the charger.

Usually, a when car is jump started, it is run to recharge (or equalize) the battery. This might NOT fully charge it! The length of time to fully recharge the battery depends on the amount of discharge, the amount of surplus current that is diverted to the battery, how long the engine is run, RPM, and temperature. That is, an alternator is sized by the car manufacturer to carry the maximum accessory load and maintain a battery--NOT recharge a dead one.

[For example, if 300 amps are consumed for ten seconds to start a car from a fully charged battery, it will take the charging system approximately two and one half minutes to replace the power used if 25 amps are available to the battery, six minutes at ten amps, or an hour at one amp. Using the same example with a dead 120 minute RC battery, it would take approximately 86 times longer to recharge it or three and one half hours at 25 amps, 8.7 hours at 10 amps, or 86.4 hours at one amp].

If you have added lights, audio amplifiers, alarms, cellular telephones or other accessories, and "stop-and-go drive occurs frequently, the alternator might NOT produce enough current to keep your battery fully charged. You might need to increase the capacity of the charging system. [Ideally the combined load of all the lights, fans, and accessories should be less than 75% of the charging system's maximum output, so that at least 25% is available to recharge the battery.]

A better method to recharge batteries is to use an external constant current charger which is set not to deliver more than 12% of the RC rating of the battery and monitor the state-of-charge. For fully discharged batteries, the following table, published by BCI, lists the recommended battery charging rates and times:

Reserve Capacity (RC) Rating	Slow Charge	Fast Charge
80 Minutes or less	15 Hours @ 3 amps	2.5 Hours @ 20 amps
80 to 125 Minutes	21 Hours @ 4 amps	3.75 Hours @ 20 amps
125 to 170 Minutes	22 Hours @ 5 amps	5 Hours @ 20 amps
170 to 250 Minutes	23 Hours @ 6 amps	7.5 Hours @ 20 amps
Above 250 Minutes	24 Hours @ 10 amps	6 Hours @ 40 amps

The BEST method is to SLOWLY recharge it using an external constant voltage (or tapered current charger) because the electrolyte has more time to penetrate the plates. A constant voltage "automatic" charger applies regulated voltage at approximately 14.4 volts. A 10 amp automatic charger will cost between $30 and $60 U.S. at an auto parts store. [To prevent damage to a fully discharged battery, the current should be less than 1% of the CCA rating during the first 30 minutes.] With a taper charger, a high current, up to 30 amps, can be applied to non-sealed batteries for a short period up to 30 minutes maximum and then is regulated downward until the charge state reaches 100%.

[An excellent automatic constant voltage battery charger is a 15 volt

regulated power supply adjusted to 14.4 volts at 80 degrees F (26.7 degrees C). If 32 degrees F (0 degrees C), then increase the charging voltage to 15.3 volts, but do NOT recharge a frozen battery. When charging a maintenance free battery, add .2 volts.]

If left unattended, a cheap, unregulated trickle battery chargers can overcharge your battery because they can "boil off" the electrolyte. Do NOT use fast, high rate, or boost chargers on any battery that is sulfated or deeply discharged. This condition requires a constant current from one to two amps for 60 to 120 hours. The electrolyte should NEVER bubble violently while recharging because high currents only create heat and excess explosive gasses.

WHAT IS PARASITIC LOAD?

Parasitic (key off) is the cumulative load produced by electrical devices, e.g., clocks, computers, alarms, etc., that operate after the engine is stopped. Parasitic loads typically run 20 to 120 milliamps. To test the parasitic load an amp meter must be inserted in series with either the positive or negative battery terminal and it's cable without the engine running. If the parasitic load is prematurely discharging your battery, start removing fuses one-at-a-time until the offending electrical component is identified. Leaving your headlights on will generally discharge a fully charged battery (with 90 minutes of Reserve Capacity) in two to six hours.

CAN I INCREASE THE LIFE OF MY BATTERY?

A. Keeping your battery and engine well maintained is the BEST way to extend the life of your battery.

For cold climates, keeping the battery fully charged and the engine warm will help increase the life of the battery. In the warmer climates and during the summer, the electrolyte levels need to be checked more frequently and DISTILLED water added, if required. This is due to the high underhood temperatures. In a study conducted by the Society of Automotive Engineers (SAE), the underhood temperature have increased 30% since 1985. Heat shields are becoming more popular and are being used by a number of car manufacturers to protect the batteries from the high underhood temperatures. Some battery manufacturers build "hot climate" versions by increasing the amount of electrolyte in the battery to provide more "cooling" or by special plate formulations. Batteries last approximately two thirds as long in hot climates as cold ones.

B. Add distilled water--NEVER add acid or tap water and DO NOT OVERFILL.

C. Turning off unnecessary accessories and lights BEFORE starting your car will decrease the load on the battery while cranking, especially when it is cold.

D. Leaving your lights or other accessories on and fully discharging the battery can ruin your car battery, especially if it is maintenance free. If this should this occur, you should test the battery AFTER it has been fully recharged to determine if there is any latent or

permanent damage.

E. Reduce the parasitic (key-off) load to 120 milliamps or less.

F. Storing fully charged batteries in cool locations and periodically recharging when they reach 80% state-of-charge or less OR six month; whichever occurs first.

G. In cold climates, increasing the diameter (smaller wire gauge) of the battery cables will increase the power available to the starter motor.

12. WHAT ARE THE MOST COMMON CAUSES OF PREMATURE BATTERY FAILURES?

A. Loss of electrolyte (which account for over 50% of the failures) due to underhood heat or overcharging,

B. Deep discharges (leaving your lights on),

C. Misapplication or using an undersized battery,

D. Undercharging or loose alternator belt,

E. Excessive vibration (due to a loose holdown clamp),

F. Using tap water,

G. Corrosion, and

H. Freezing.

WHAT ARE SOME OF THE MYTHS ABOUT BATTERIES?

A. Storing a battery on a concrete floor will discharge them.

Modern lead acid battery cases are better sealed, so external leakage causing discharge is no longer a problem. [Temperature stratification within large batteries can accelerate the internal "leakage" or self discharge if the battery is sitting on an extremely cold floor in a warm room or installed in a submarine.]

B. Driving a car will fully recharge a battery.

There are a number of factors affecting alternator's ability to charge a battery. The greatest factors are how much current from the alternator is diverted to the battery to charge it, how long the current is available and temperature. Generally, running the engine at idle or short "stop-and go trips" during bad weather at night will not recharge the battery.

C. A battery will not explode.

While spark retarding vent caps help, recharging a battery produces hydrogen and oxygen gasses. Battery explosions can also occur when the electrolyte level is below the top of the plates. If a spark or flame occurs, an explosion will occur. Remember the "Hindenburg"!

D. A battery will not lose it's charge sitting in storage.

A battery has self discharge or internal electrochemical "leakage" that will cause it to become fully discharged and sulfated over time. Prior to storing a battery, it should be fully charged, placed in a cool location above freezing, and recharged when it reaches the 80% state-of-charge level or once every six months, whichever occurs first. If left in a vehicle, disconnect the negative cable.

E. Maintenance free batteries never requires electrolyte.

In hot climates, the electrolyte could be "boiled off" due to the high underhood temperatures . Electrolyte could also be lost due to excessive charging voltage or charging currents.

F. Test the alternator by disconnecting the battery with the engine running.

A battery as like a voltage stabilizer or filter to the pulsating DC produced by the alternator. Disconnecting a battery while the engine is running can destroy the electronic components, e.g., computers, radio, stereo, alarm system, etc., or the charging system. Just say NO! if anyone suggests this.

Battery Tips

1. Overcharging

- **Severely corrodes positive plate grids, so that they weaken and may cause the plates to disintegrate. Positive plates are frequently warped.**
- **Decomposes electrolyte into Hydrogen and Oxygen gas and the excessive loss of water makes the electrolyte get concentrated to an extent that is damaging to plates and separators.**
- **Creates high temperatures in the battery, which accelerate positive plate corrosion and may damage separators, plastic separator guards and distort the container.**
- **Severe gassing may blow away active material from the plate surface causing loss in capacity and also give rise to a fine acid spray escaping from the battery.**

Solution

- **Correct fan belt tension**
- **Correct voltage setting of the alternator**

2. Impure topping up of water and neglect of topping up

- **Impure water or electrolyte introduces impurities into the battery, which accumulate with each such topping up.**

- **The most common impurities are iron and chlorine, which attack plates and shorten the overall life.**
- **Chlorine also attacks and bleaches the separators**
- **Neglecting to top up the water leads to an increase in the concentration of acid in the electrolyte and consequently damages the plates.**
- **The plate areas above the electrolyte level get hard and lose capacity.**

Solution
- **Always top up with pure distilled water when the electrolyte level is low.**

3. Undercharging

- **Persistent undercharging results in the sulphation of plates and a running down of cells. This also causes lead sulphate deposits on separators, which lead through and create short circuits between positive and negative plates. Undercharging may also lead to the buckling of plates.**

Solution
- **Correct fan belt tension**
- **Correct voltage setting of the alternator**

4. Leaving Batteries Idle

- **This causes the battery to run down due to self discharge. The lead sulphate crystals formed as a result of self discharge grow as the battery stands idle, and are not easily converted back on recharge. The sulphation, in other words, tend to become permanent thus affecting battery capacity and lowering battery life.**

Solution
- **Ensure that batteries lying idle are given a freshening charge.**

5. Container Damage

Container damage arises from:

- **Thermal deformation due to overcharge**
- **Deformation due to excessive tightening**
- **Damage by external forces and impacts**
- **Damage by internal pressure or flashed explosion**

This may physically damage the plates and separators in cells or cause leakage of electrolyte so that the battery becomes unserviceable.

Solution
- **Handle your battery with care**

6. Daily Inspections

Checking of electrolyte level

- **Maintain electrolyte level between the upper and lower level lines.**
- **If the electrolyte gets low, fill pure water up to the upper level.**
- **Never fill water over the upper level line.**

Inspection of loosening and corrosion of terminals

- **If the terminals are corroded, remove rust with a wire brush and apply rust proof grease.**

Cleaning

- **A dirty battery causes leakage of electricity.**
- **Wet cloth should be used in cleaning. If dry one is used, there is danger of explosion due to electrostatic spark.**

Q. ***Does a running vehicle in the daytime with headlights on reduce gas-mileage and the battery life time, and how much?***

A: If the headlights are on, the dashboard lights and the car's rear lights are on too. Assume the current drain is 20 amperes, more or less depending on the type of car. That will be about 240 watt-hours for each hour of driving time. That energy has to come from somewhere. Your gas-mileage will decrease. How much, depends mainly on your car.

The effect on battery life should be nil. Two factors most responsible for decreases in battery life are high temperatures, and frequent deep discharges of the battery.

Hazards

- **Automotive batteries contain sulfuric acid that can burn skin.**

Handling

- **Handle batteries with acid resistant or leather gloves.**
- **Keep sparks and flames away from batteries and don't smoke nearby.**
- **Never place metal objects on top of the battery because it can cause sparks. Remove rings, chains, and other metallic items before handling.**
- **Keep batteries right side up.**
- **Carry in a non-metallic, leak proof container.**
- **If battery leaks, neutralize any spilled acid with baking soda or calcium carbonate (lime). Flush area with water.**
- **If acid comes in contact with skin, flush area with water immediately, and seek medical attention if burning continues.**

Management Options

- **Do not throw in the trash.**
- **Most automotive battery retailers will accept used batteries when purchasing a new one.**
- **Take to community recycling center, if available.**
- **Take to service station or repair garage that accepts automotive batteries. Many garages, auto salvage operations, and scrap metal yards will take automotive batteries, provided they are not broken or leaking. Some will pay approximately $1 each. Consult Recycling Services Directory for closest locations.**
- **Most household hazardous waste events accept automotive batteries**

Dead Batteries

It is easy to identify a dead battery of an automobile. Just start the engine. If it starts immediately, the battery is in good health. If it takes time, then the battery is weak. And if it can not crank the engine, the battery is considered as dead. The battery may be good, and the alternator may not be working, or the fan belt may be loose. In that case, you can remove the battery from the vehicle, put it on a battery charger and get it charged. If the conditions do not improve, then the battery must be discarded. Many times a vehicle battery fails all of a sudden without a warning and the owner is subjected to a lot of inconvenience, and sometimes embarrassment.

The stationery and traction batteries normally do not fail suddenly as in the case of automobile batteries. They gradually become weaker and weaker with the passage of time. Their working time keeps on diminishing and the charging time keeps on increasing. At a certain stage, the batteries are so weak that they work only for a short duration, and has to be discarded.

It is very difficult for the owner of a three wheelers in Bombay suburbs to know when his battery has failed ! The reason is that the battery is used only for lighting purpose and the electric bulbs keep glowing even at 9 volts.

The reason for a battery becoming weak is sulfation. During the lifetime of the battery, the sulphates from the sulphuric acid keep on accumulating on the battery plates, thus lowering the specific gravity of the electrolyte. When a weak or dead battery is subjected to pulse treatment, usually the battery responds well, and the specific gravity shows improvements.

The automobile battery plates are made porous in order to increase the surface area. If the plates of a heavily sulfated automobile battery stay corroded for a long time, the plates can be damaged or even ruined. The most protective and efficient way is to put a EuroPULSE unit on a battery before the lead sulfate has made any damage to the plates. EuroPULSE unit is primarily designed to be a maintenance device. But it has proven to be a very efficient tool for removing lead sulfates from old batteries and even restoring most of them back to an extended lifetime.

Special care should be taken when reviving a dead or very weak battery. First the battery should be charged for a few hours without EuroPULSE. If the battery is not taking a charging current, high voltage can be applied for a short duration. This helps the current to start flowing. Once the current stabilises, the EuroPULSE unit can be put into action. The charging current should be kept at low.

Special attention should be paid for any rise in the temperature. If the battery becomes hot, the charging should be discontinued and battery should be allowed to cool down. After charging the battery should be tested for load and again it should be charged.

Is it true that refrigerating batteries will extend shelf life? If so, why does a cold car battery cause slower starts? The answer will help me sleep better. — Kevin C., Alexandria, Virginia

Whatever it takes, dude. Refrigerating batteries extends shelf life because batteries produce electricity through a chemical reaction. Heat speeds up any reaction, while cold slows it down. Freeze your [car battery] and you'll extend its life because the juice won't leak away—but it'll also make those volts a little tough to use right away. That accounts for the belief occasionally voiced by mechanics that if a battery is left on the garage floor for an extended period, the concrete will "suck out the electricity." It does nothing of the kind, but a cold floor will substantially reduce a battery's output. The cure: warm it up first.

Charging Lead-Acid Batteries

Constant potential charging, with current limiting, is usually recommended for sealed lead-acid cells. Due to the sloping voltage profile of a lead-acid battery, the voltage of the battery is a reliable indicator of its state of charge. Current limiting may be accomplished through the use of a current-limiting resistor. One manufacturer uses a miniature light bulb as a current-limiting resistor. The brightness of the bulb will provide a visual indication of the state of charge of the battery. In modern practice, however, current limiting is accomplished with integrated circuits.

A Glossary of Battery Terms

- **Ampere-Hour -- One ampere-hour is equal to a current of one ampere flowing for one hour. A unit-quantity of electricity used as a measure of the amount of electrical charge that may be obtained from a storage battery before it requires recharging.**

- **Ampere-Hour Capacity -- The number of ampere-hours which can be delivered by a storage battery on a single discharge. The ampere-hour capacity of a battery on discharge is determined by a number of factors, of which the following are the most important: final limiting voltage; quantity of electrolyte; discharge rate; density of electrolyte; design of separators; temperature, age, and life history of the battery; and number, design, and dimensions of electrodes.**

- **Anode -- In a primary or secondary cell, the metal electrode that gives up electrons to the load circuit and dissolves into the electrolyte.**

- **Aqueous Batteries -- Batteries with water-based electrolytes.**

- **Available Capacity -- The total battery capacity, usually expressed in ampere-hours or milliampere-hours that are available to perform work. This depends on factors such as the endpoint voltage, quantity and density of electrolyte, temperature, discharge rate, age, and the life history of the battery.**

- **Battery -- A device that transforms chemical energy into electric energy. The term is usually applied to a group of two or more electric cells connected together electrically. In common usage, the term "battery" is also applied to a single cell, such as a household battery.**

- **Battery Types -- There are, in general, two type of batteries: primary batteries, and secondary storage or accumulator batteries. Primary types, although sometimes consisting of the same active materials as secondary types, are constructed so that only one continuous or intermittent discharge can be obtained. Secondary types are constructed so that they may be recharged, following a partial or complete discharge, by the flow of direct current through them in a direction opposite to the current flow on discharge. By recharging after discharge, a higher state of oxidation is created at the positive plate or electrode and a lower state at the negative plate, returning the plates to approximately their original charged condition.**

- **Battery Capacity -- The electric output of a cell or battery on a service test delivered before the cell reaches a specified final electrical condition and may be expressed in ampere-hours, watt-hours, or similar units. The capacity in watt-hours is equal to the capacity in ampere-hours multiplied by the battery voltage.**

- **Battery Charger -- A device capable of supplying electrical energy to a battery.**

- **Battery-Charging Rate -- The current expressed in amperes at which a storage battery is charged.**

- **Battery Voltage, final -- The prescribed lower-limit voltage at which battery discharge is considered complete. The cutoff or final voltage is usually chosen so that the useful capacity of the battery is realized. The cutoff voltage varies with the type of battery, the rate of discharge, the temperature, and the kind of service in which the battery is used. The term "cutoff voltage" is applied more particularly to primary batteries, and "final voltage" to storage batteries. Synonym: Voltage, cutoff.**

- **C_i -- The rated capacity, in ampere-hours, for a specific, constant discharge current (where *i* is the number of hours the cell can deliver this current). For example, the C_5 capacity is the ampere-hours that can be delivered by a cell at constant current in 5 hours. As a cell's capacity is not the same at all rates, C_5 is usually less than C_{20} for the same cell.**

- **Capacity -- The quantity of electricity delivered by a battery under specified conditions, usually expressed in ampere-hours.**

- **Cathode -- In a primary or secondary cell, the electrode that, in effect, oxidizes the anode or absorbs the electrons.**

- **Cell -- An electrochemical device, composed of positive and negative plates, separator, and electrolyte, which is capable of storing electrical energy. When encased in a container and fitted with terminals, it is the basic "building block" of a battery.**

- **Charge -- Applied to a storage battery, the conversion of electric energy into chemical energy within the cell or battery. This restoration of the active materials is accomplished by maintaining a**

unidirectional current in the cell or battery in the opposite direction to that during discharge; a cell or battery which is said to be charged is understood to be fully charged.

- **Charge Rate -- The current applied to a secondary cell to restore its capacity. This rate is commonly expressed as a multiple of the rated capacity of the cell. For example, the C/10 charge rate of a 500 Ah cell is expressed as,**

C/10 rate = 500 Ah / 10 h = 50 A.

- **Charge, state of -- Condition of a cell in terms of the capacity remaining in the cell.**
- **Charging -- The process of supplying electrical energy for conversion to stored chemical energy.**
- **Constant-Current Charge -- A charging process in which the current of a storage battery is maintained at a constant value. For some types of lead-acid batteries this may involve two rates called the starting and finishing rates.**
- **Constant-Voltage Charge -- A charging process in which the voltage of a storage battery at the terminals of the battery is held at a constant value.**
- **Cycle -- One sequence of charge and discharge. Deep cycling requires that all the energy to an end voltage established for each system be drained from the cell or battery on each discharge. In shallow cycling, the energy is partially drained on each discharge; *i.e.*, the energy may be any value up to 50%.**
- **Cycle Life -- For secondary rechargeable cells or batteries, the total number of charge/discharge cycles the cell can sustain before it becomes inoperative. In practice, end of life is usually considered to be reached when the cell or battery delivers approximately 80% of rated ampere-hour capacity.**
- **Depth of Discharge -- The relative amount of energy withdrawn from a battery relative to how much could be withdrawn if the battery were discharged until exhausted.**
- **Discharge -- The conversion of the chemical energy of the battery into electric energy.**
- **Discharge, deep -- Withdrawal of all electrical energy to the end-point voltage before the cell or battery is recharged.**
- **Discharge, high-rate -- Withdrawal of large currents for short intervals of time, usually at a rate that would completely discharge a cell or battery in less than one hour.**
- **Discharge, low-rate -- Withdrawal of small currents for long periods of time, usually longer than one hour.**
- **Drain -- Withdrawal of current from a cell.**

- **Dry Cell -- A primary cell in which the electrolyte is absorbed in a porous medium, or is otherwise restrained from flowing. Common practice limits the term "dry cell" to the Leclanché cell, which is the common commercial type.**

- **Electrochemical Couple -- The system of active materials within a cell that provides electrical energy storage through an electrochemical reaction.**

- **Electrode -- An electrical conductor through which an electric current enters or leaves a conducting medium, whether it be an electrolytic solution, solid, molten mass, gas, or vacuum. For electrolytic solutions, many solids, and molten masses, an electrode is an electrical conductor at the surface of which a change occurs from conduction by electrons to conduction by ions. For gases and vacuum, the electrodes merely serve to conduct electricity to and from the medium.**

- **Electrolyte -- A chemical compound which, when fused or dissolved in certain solvents, usually water, will conduct an electric current. All electrolytes in the fused state or in solution give rise to ions which conduct the electric current.**

- **Electropositivity -- The degree to which an element in a galvanic cell will function as the positive element of the cell. An element with a large electropositivity will oxidize faster than an element with a smaller electropositivity.**

- **End-of-Discharge Voltage -- The voltage of the battery at termination of a discharge.**

- **Energy -- Output capability; expressed as capacity times voltage, or watt-hours.**

- **Energy Density -- Ratio of cell energy to weight or volume (watt-hours per pound, or watt-hours per cubic inch).**

- **Float Charging -- Method of recharging in which a secondary cell is continuously connected to a constant-voltage supply that maintains the cell in fully charged condition.**

- **Galvanic Cell -- A combination of electrodes, separated by electrolyte, that is capable of producing electrical energy by electrochemical action.**

- **Gassing -- The evolution of gas from one or both of the electrodes in a cell. Gassing commonly results from self-discharge or from the electrolysis of water in the electrolyte during charging.**

- **Internal Resistance -- The resistance to the flow of an electric current within the cell or battery.**

- **Memory Effect -- A phenomenon in which a cell, operated in successive cycles to the same, but less than full, depth of discharge, temporarily loses the remainder of its capacity at normal voltage levels (usually applies only to Ni-Cd cells).**

- **Negative Terminal -- The terminal of a battery from which electrons flow in the external circuit when the cell discharges.**

- **Nonaqueous Batteries -- Cells that do not contain water, such as those with molten salts or organic electrolytes.**

- **Ohm's Law -- The formula that describes the amount of current flowing through a circuit. Voltage = Current × Resistance.**

- **Open Circuit -- Condition of a battery which is neither on charge nor on discharge (*i.e.*, disconnected from a circuit).**

- **Open-Circuit Voltage -- The difference in potential between the terminals of a cell when the circuit is open (*i.e.*, a no-load condition).**

- **Oxidation -- A chemical reaction that results in the release of electrons by an electrode's active material.**

- **Parallel Connection -- The arrangement of cells in a battery made by connecting all positive terminals together and all negative terminals together, the voltage of the group being only that of one cell and the current drain through the battery being divided among the several cells. See Series Connection.**

- **Polarity -- Refers to the charges residing at the terminals of a battery.**

- **Positive Terminal -- The terminal of a battery toward which electrons flow through the external circuit when the cell discharges.**

- **Primary Battery -- A battery made up of primary cells. See Primary Cell.**

- **Primary Cell -- A cell designed to produce electric current through an electrochemical reaction that is not efficiently reversible. Hence the cell, when discharged, cannot be efficiently recharged by an electric current. Note: When the available energy drops to zero, the cell is usually discarded. Primary cells may be further classified by the types of electrolyte used.**

- **Rated Capacity -- The number of ampere-hours a cell can deliver under specific conditions (rate of discharge, end voltage, temperature); usually the manufacturer's rating.**

- **Rechargeable -- Capable of being recharged; refers to secondary cells or batteries.**

- **Recombination -- State in which the gasses normally formed within the battery cell during its operation, are recombined to form water.**

- **Reduction -- A chemical process that results in the acceptance of electrons by an electrode's active material.**

- **Seal -- The structural part of a galvanic cell that restricts the escape of solvent or electrolyte from the cell and limits the ingress of air into the cell (the air may dry out the electrolyte or interfere with the chemical reactions).**

- **Secondary Battery -- A battery made up of secondary cells. See Storage Battery; Storage Cell.**

- **Self Discharge -- Discharge that takes place while the battery is in an open-circuit condition.**

- **Separator -- The permeable membrane that allows the passage of ions, but prevents electrical contact between the anode and the cathode.**

- **Series Connection -- The arrangement of cells in a battery configured by connecting the positive terminal of each successive cell to the negative terminal of the next adjacent cell so that their voltages are cumulative. See Parallel Connection.**

- **Shelf Life -- For a dry cell, the period of time (measured from date of manufacture), at a storage temperature of 21°C (69°F), after which the cell retains a specified percentage (usually 90%) of its original energy content.**

- **Short-Circuit Current -- That current delivered when a cell is short-circuited (*i.e.*, the positive and negative terminals are directly connected with a low-resistance conductor).**

- **Starting-Lighting-Ignition (SLI) Battery -- A battery designed to start internal combustion engines and to power the electrical systems in automobiles when the engine is not running. SLI batteries can be used in emergency lighting situations.**

- **Stationary Battery -- A secondary battery designed for use in a fixed location.**

- **Storage Battery -- An assembly of identical cells in which the electrochemical action is reversible so that the battery may be recharged by passing a current through the cells in the opposite direction to that of discharge. While many non-storage batteries have a reversible process, only those that are economically rechargeable are classified as storage batteries. Synonym: Accumulator; Secondary Battery. See Secondary Cell.**

- **Storage Cell -- An electrolytic cell for the generation of electric energy in which the cell after being discharged may be restored to a charged condition by an electric current flowing in a direction opposite the flow of current when the cell discharges. Synonym: Secondary Cell. See Storage Battery.**

- **Taper Charge -- A charge regime delivering moderately high-rate charging current when the battery is at a low state of charge and tapering the current to lower rates as the battery becomes more fully charged.**

- **Terminals -- The parts of a battery to which the external electric circuit is connected.**

- **Thermal Runaway -- A condition whereby a cell on charge or discharge will destroy itself through internal heat generation caused by high overcharge or high rate of discharge or other abusive conditions.**

- **Trickle Charging -- A method of recharging in which a secondary cell is either continuously or intermittently connected to a constant-current supply that maintains the cell in fully charged condition.**

- **Vent -- A normally sealed mechanism that allows for the controlled escape of gases from within a cell.**

- **Voltage, cutoff -- Voltage at the end of useful discharge. (See Voltage, end-point.)**

- **Voltage, end-point -- Cell voltage below which the connected equipment will not operate or below which operation is not recommended.**

- **Voltage, nominal -- Voltage of a fully charged cell when delivering rated current.**

- **Wet Cell -- A cell, the electrolyte of which is in liquid form and free to flow and move**

The common automobile batteries in which the electrodes are grids of metallic lead containing lead oxides that change in composition during charging and discharging. The electrolyte generally is dilute sulfuric acid.

Even after over 100 years, the Lead-Acid battery is still the battery of choice for 99% of solar and backup power systems. With the better availability and afffordability of deep-cycle batteries, we feel that there is little reason to use any other type (FOR NOW!).