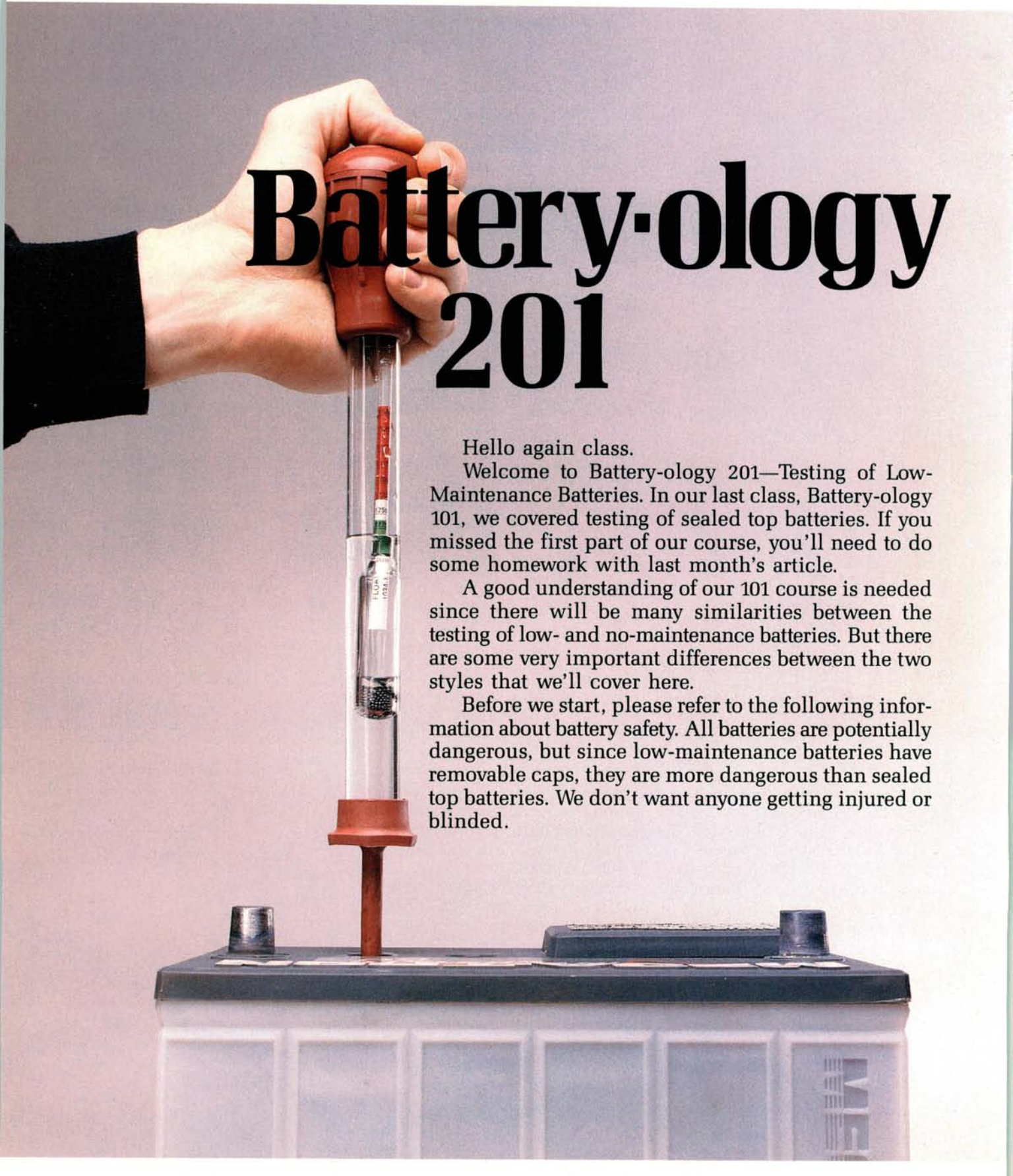
Battery-ology 201



Hello again class.

Welcome to Battery-ology 201—Testing of Low-Maintenance Batteries. In our last class, Battery-ology 101, we covered testing of sealed top batteries. If you missed the first part of our course, you'll need to do some homework with last month's article.

A good understanding of our 101 course is needed since there will be many similarities between the testing of low- and no-maintenance batteries. But there are some very important differences between the two styles that we'll cover here.

Before we start, please refer to the following information about battery safety. All batteries are potentially dangerous, but since low-maintenance batteries have removable caps, they are more dangerous than sealed top batteries. We don't want anyone getting injured or blinded.

Battery Safety

The following steps should be remembered anytime you're working around any lead-acid battery:

• **Prevent Battery Explosions.** An automotive battery can be a bomb. All batteries gas while charging. Gassing increases as the battery is charged, and is greatest at the end of the charging cycle.

This gas is explosive.

Always charge batteries in a well ventilated area. Leave the battery caps in place, and let the gases leave the battery through the vents in the battery top. WEAR EYE PROTECTION. Place a wet rag across the caps as added protection against a stray spark.

Gloves and a long sleeved shirt are also a good idea. Wash your hands immediately after handling a battery.

NO SMOKING around a battery or when working in an area where batteries are stored. We know you've all heard this so often that you're sick of hearing it again, but the first serious mistake you make is the one you'll never forget.

Remove battery plastic wrappings before charging or installing a battery in a vehicle.

Handling Battery Acid

If you need to mix pure sulfuric acid with distilled water ALWAYS POUR THE ACID INTO THE WATER. Never pour water into the acid. Why? Because water is lighter than the acid, and won't break the surface of the acid. This could cause the acid to splatter and the water to rest on top of the acid until it can gradually mix with the acid.

Once again, gloves and goggles are your minimum tool requirements when dealing with sulfuric acid and water.

Topping Off A Battery Low On Electrolyte

Never add anything but distilled water to a battery already in service, and always use an approved water dispenser for safety's sake. Old juice cans and garbage can lids are not approved dispensers. In fact, any wide-mouthed container can cause you to overfill the battery. Overfilling causes two problems: it shortens battery life, and overflowing electrolyte is hardly a paint job's best friend.

Battery History 201

A quick look at the history of the automotive battery will help us understand how batteries have changed. Batteries were available long before Henry built his first model T. Alexander Graham Bell, Ma Bell's daddy, used a primitive battery to make his first local call in 1876. In fact, lead-acid batteries date back to 1859.

But the big change came when somebody figured out how to recharge a lead-acid battery. From that point on, cars and batteries formed a natural team.

Well, sort of.

Old style batteries had a lot of problems, just like old style tires. Both liked to go flat on a regular basis. Early batteries used a lot of water, didn't hold a charge very well, and died at a very early age.

But the joys of motoring experienced by my grandfather more than made up for flat tires and dead batteries. So the lead-acid battery didn't change a whole lot until the joys of motoring were replaced by the need to get to work at nine o'clock sharp, day after day.

During the 1960s, there were some important changes in battery chemistry. We were suddenly blessed with "low-maintenance" batteries that used less water, held a charge better, and lived a lot longer.

MYTHS AND LEGENDS

Old ideas die hard. Because old style batteries couldn't hold a charge very well, an idea grew that placing a battery on a concrete floor made it discharge faster. It's not true. The simple truth is that these batteries wouldn't hold a charge very well no matter where you placed them. Now that we have better batteries that hold a charge much longer, the idea still hangs on. Forget it. *(But it's still fun to watch an old-timer sweat when you place a battery on a concrete floor.)*

Low-Maintenance Battery Chemistry 201

Currently, we have two basic types of automotive batteries in use: low-maintenance and maintenance-free.

• Low-maintenance and maintenance-free batteries have negative grids that are reinforced with calcium. The big difference between the two types is in the *positive* grids.

• Low-maintenance batteries add low levels of antimony to the lead in their positive grids. These antimony-calcium positive grids are called dual-alloy as a result.

• Maintenance-free batteries use only calcium in the positive grids. They are called calcium-calcium as a result.

Benefits Of Dual-Alloy Batteries

Dual alloy batteries have some nice features.

• They take a charge easily, so it's easier for the car's charging system to keep them fully charged.

• Since they charge easily, they also charge at a lower charging voltage.

• They can be deep discharged and recharged many

times, which is a blessing for the customer who forgets to turn off his headlights on a regular basis.

• Most low-maintenance batteries have better reserve capacities than maintenance-free batteries. This is a big plus when you lose your alternator belt in the middle of nowhere.

Limitations Of Dual-Alloy Batteries

Nobody's perfect.

Dual alloy batteries are no exception.

• Low-maintenance batteries can lose water if the charging rate is too high. Adding distilled water corrects this problem, but that means "maintenance," a term not normally found in the driver's vocabulary list.

• The charging voltage set point becomes important as a result. If you have no control of the charging voltage set point, you'll need to check battery water every 90 days or so.

• Low-maintenance batteries have a shorter shelf life when stored wet. After 90 days of storage, these batteries need a short charge to bring them back to a fully charged state.

Specific Gravity

A little history, a little chemistry, and now a little physics. Who says you don't get your money's worth in this class? The physics part has to do with something called specific gravity. The reference, or starting point for measuring the mass of a liquid is distilled water at 4 degrees C. The specific gravity of this water is given the number 1.000. By comparison, sulfuric acid is denser, and has a specific gravity of 1.840.

Specific Gravity Vs. State Of Charge

Specific Gravity		State Of Charge
1.270	Okay To Load Test	100%
1.225	Okay To Load Test	75%
1.190	Do Not Load Test	50%
1.155	Do Not Load Test	25%
1.120	Do Not Load Test	0%

(Courtesy of Battery Council International)

When we mix the two together, we get a reading somewhere in between those two numbers. The lower the number, the more water there is in the solution. The higher the number, the more acid we have. Since the battery state of charge is directly related to the specific gravity of the electrolyte solution, we can measure specific gravity with a hydrometer and have a very accurate indication of the battery's state of charge.

Hydrometers

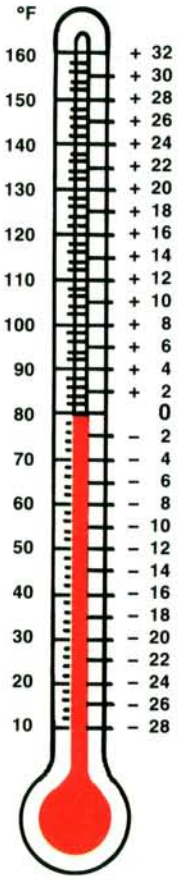
Charging a battery pulls acid out of the battery plates and puts it back into the electrolyte solution where it belongs. A fully charged battery has a specific gravity of 1.265-1.275. As the battery discharges, there's more water, less acid in the electrolyte, and specific gravity goes down.

There are different styles of hydrometers. Some use floating balls or discs. Some have a float that pivots, like an anti-freeze tester. I prefer a large, vertical hydrometer with a tall float for two reasons:

• It's more accurate.

• It lets you take a larger sample of the electrolyte solution.

Thermometer Showing Fahrenheit Correction Factor For Hydrometer Readings



When Cold

EXAMPLE No. 1—
Temperature Below 80°F.

Hydrometer Reading 1.250
Acid Temperature 20°F.
Subtract .024 Sp. Gr.
Corrected Sp. Gr. Is 1.226

When Hot

EXAMPLE No. 2—
Temperature Above 80°F.

Hydrometer Reading 1.235
Acid Temperature 100°F.
Add .008 Sp. Gr.
Corrected Sp. Gr. Is 1.243

(Courtesy of Battery Council International)

Hydrometers are calibrated to be accurate at a certain temperature. But temperature readings above or below 80 degrees F require us to make corrections for that change. The reason we need to make these corrections has to do with expansion or contraction of the electrolyte solution caused by temperature changes. In extreme temperatures, this can make a big difference in your readings.

- For each 10 degree temperature change above 80 degrees F, add 0.004 points to the hydrometer reading.
- For each 10 degree change below 80 degrees F, subtract 0.004 points from the hydrometer reading.

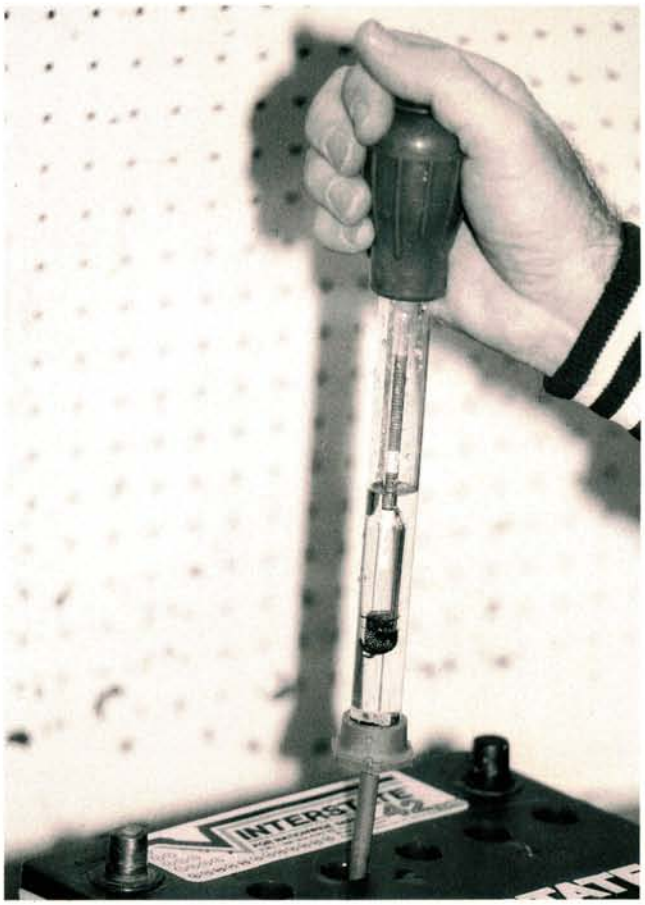
Let's go to the lab and put some of this theory to use testing batteries.

Battery Lab 201

Lesson: Testing Low-Maintenance Batteries In Five Easy Steps

STEP ONE—Visual Inspection

Inspect the battery case for cracks or damage. Check the battery posts for corrosion. Check the electrolyte level in each cell. If the level is low, add distilled water (never acid) to the bottom of the vent well. Do not overfill. If the battery is very cold, leave a little extra room for the electrolyte to expand as the battery warms.



STEP TWO—Charge Acceptance Test

Charge the battery for three minutes at 20-25 amps. Some batteries are sulfated, and won't take a charge. Remove surface charge created by the charging by loading the battery to 150 amps for 10 seconds with a load tester. Then let the battery rest for 10 minutes. We don't want surface charge giving us false readings.

A battery that won't accept a 20-25 amp charge for three minutes is telling us one of two things:

- It can't accept a charge because it's sulfated from being at a low state of charge for too long.
- The battery is fully charged and doesn't need to be charged.

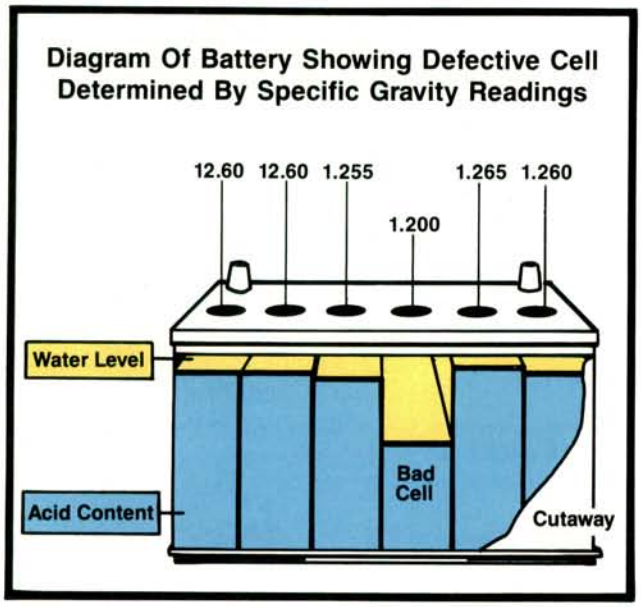
Step three will answer this question for us.

STEP THREE—Determine State Of Charge

This is a very important step and must be done with great care. With surface charge removed, check the specific gravity. It doesn't take more than a minute to check all six cells. Correct your readings for temperature using our chart. Then you'll know for sure what shape the battery is in. Compare your findings to the following conditions:

- One Cell 50 Points Low. This means big trouble in River City. The cell with low specific gravity is bad. The battery is junk. If none of the cells is 50 points

lower than the rest, and the lowest cell reads at least 1.225, go to the next step.



• If no cell is 50 points off and all cells are above 1.225, the battery is at 75 percent of full charge. It can be load tested. There is enough acid in the water to give the battery a fighting chance of passing a load test.
• If no cell is 50 points off, but a cell or cells in the battery are below 1.225, the battery is below 75 percent of full charge. We can't be sure at this point if the battery is good or bad. We do know that it won't pass a load test in this weakened state. Too much acid is in the plates, and not in the electrolyte solution. Recharge the battery and retest. If specific gravity is still below 1.225 after a recharge, the battery is no good.

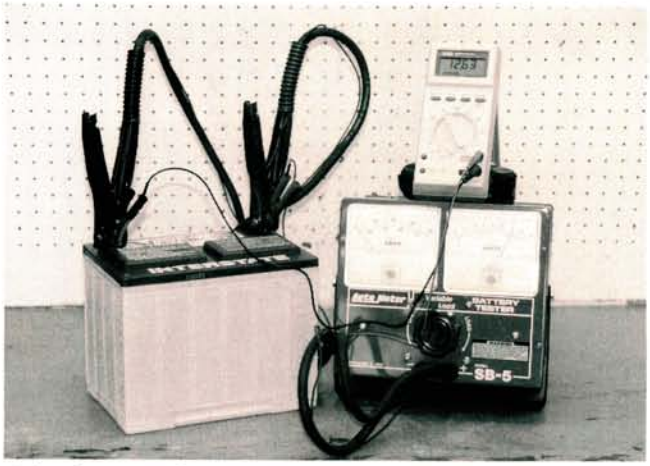
Many batteries are scrapped because they were load tested below 75 percent of full charge. Even good batteries will fail the test if they are load tested when below 75 percent of full charge.

The best test of a battery is done with the battery at full charge (specific gravity of 1.265-1.275).

STEP FOUR—The Load Test

A load test is a little like a stress test. We want to put our battery on the treadmill and see if it breathes hard when it has to do some real work. The load test will tell us if the battery can deliver a specific amount of current, and still maintain an acceptable terminal post voltage at a given temperature.

Set up the load test as follows:
• **Connect the carbon pile load tester cables to the battery posts**. If the load tester has a temperature range select knob, adjust it to match battery temperature.
• **Connect a DVOM with a DC accuracy of ±0.25 percent or better to the battery posts**. Use the ammeter readings from the load tester and the DVOM voltage readings when evaluating the load test.



A load test can be performed on the bench or in the car.

Perform the load test as follows:
• **Adjust the load tester until the current draw on the battery is ½ the cold crank amp rating (CCA) of the battery**. Hold this current draw for 15 seconds. At 15 seconds, note the DVOM reading. Then turn off the load tester.

(If the CCA rating of the battery is not known, use the CCA rating for the recommended battery for that car. Or you can ask your battery supplier for a battery replacement manual that will list those specifications.)

Battery Temperature Vs. Voltage DVOM Readings After 15 Second Load Test

Battery Temperature	Battery Terminal Voltage
70 degrees F	9.60 volts
60 degrees F	9.50 volts
50 degrees F	9.40 volts
40 degrees F	9.30 volts
30 degrees F	9.10 volts
20 degrees F	8.90 volts
10 degrees F	8.70 volts
0 degrees F	8.50 volts

(Courtesy of Battery Council International)

Evaluate the Load Test as follows:
• **Compare the DVOM readings from the load test to our Temperature vs. Voltage Chart**. Battery voltage will drop during a load test. The question is, did it drop too far for the temperature of the battery being tested?
• **If the battery post voltage falls below the minimum acceptable level on our chart for that battery temperature, the battery *fails* the load test.**
• **If the battery voltage is higher than the minimum acceptable level on the chart for that battery temperature, the battery *passes* the load test.**

Tips On Evaluating The Load Test Results

Here are some fine points and tips for evaluating load test results. They'll help you know the difference between a really good battery, one that's just okay, and a boat anchor:

- Batteries are like students. Some pass the course with a grade of A, but some struggle to get a C. If the battery post voltage readings are above the minimum acceptable readings on the chart, our test battery gets an A for the test. This is a good battery with a good reserve of power.
- If the battery just barely passes the test, refer back to step three. If the battery was tested at 100 percent of charge, and just barely passed, it's a C student and no more. It doesn't have any reserve, and will probably fail under extreme load and temperature conditions. Don't feel guilty about replacing a battery like this.
- If the battery just passed the test, but did so at 75 percent of full charge with a specific gravity reading at or close to 1.225 on all six cells, the battery is a good one. It would have gotten that A in a fully charged state.

This is where some technicians get in trouble. They assume the battery is bad, when the real problem is that something in the car is keeping the battery from being fully charged. A new battery will not cure the problem.

STEP FIVE—What To Do If The Battery Fails The Load Test

We'll run one final test on those batteries that flunk the load test, just to be sure. Leave the DVOM attached to the battery posts for a few more minutes. We're testing "bounce back" voltage.

If the voltage bounces back to 12.45 volts or higher after a few minutes, the battery is working. With bounce back voltage like this, it has no excuse for flunking the load test. It just can't supply both voltage and current under load. Replace it.

If the voltage doesn't bounce back to 12.45 volts or higher, don't just assume the battery is bad, especially if it wasn't fully charged when tested. There is still a possibility that this battery would pass in a fully charged state. If you skipped Step Three, you can't be sure at this point. Fully charge this battery and retest it.

How Do You Know It's Fully Charged?

I'm glad someone asked that question. There are three ways to tell if a battery is fully charged:

- If the specific gravity holds at 1.265 to 1.275 after the surface charge is removed, the battery is fully charged.
- If the terminal post voltage holds at 12.68 volts after the surface charge has been removed, the battery is fully charged.
- If the ammeter on the battery charger falls to a low charging level (usually 3 amps or less depending on the battery type and the presence of impurities in the electrolyte) and stays there for one hour, the battery is fully charged.

Terminal Post Voltage Vs. State Of Charge

Voltage		State Of Chage
12.68	Okay To Load Test	100%
12.45	Okay To Load Test	75%
12.24	Do Not Load Test	50%
12.06	Do Not Load Test	25%
11.89	Do Not Load Test	0%

(Courtesy of Battery Council International)

Proper Battery Charging

What is the proper way to charge a battery without causing excessive gassing or damaging the battery? That's another good question. Battery Council International offers the following chart, matching battery charge rates to the battery's reserve capacity.

Charge Chart For Low And No-Maintenance Batteries

Reserve Capacity (In Minutes)	Slow Charge	Fast Charge
80	15 hrs @ 3 amps	2.5 hrs @ 20 amps 1.5 hrs @ 30 amps
80-125	21 hrs @ 4 amps	3.7 hrs @ 20 amps 1.5 hrs @ 50 amps
125-170	22 hrs @ 5 amps	5.0 hrs @ 20 amps 2.0 hrs @ 50 amps
170-250	23 hrs @ 6 amps	7.5 hrs @ 20 amps 3.0 hrs @ 50 amps
250 and up	24 hrs @ 10 amps	6.0 hrs @ 40 amps 4.0 hrs @ 60 amps

(Courtesy of Battery Council International)

Class Review

We hope our two classes on battery testing will help you tell the good ones from the bad ones when it comes to battery testing. There is no test or final exam. The real test will come out in the bays each time a customer shows up with a dead battery. Here's hoping you all pass with flying colors.

—By Vince Fischelli