

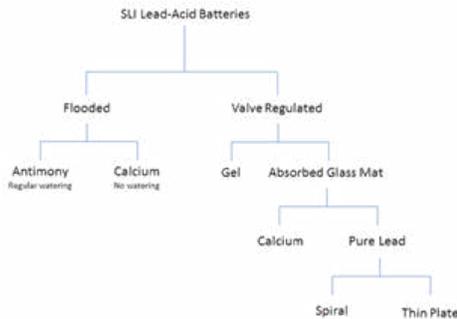


- [New Product Information](#)
- [Latest News](#)
- [Online Buyer's Guide](#)
- [Upcoming Events](#)
- [Current Issue](#)
- [Law and Order Homepage](#)
- [Law and Order Media Kit Request](#)
- [Law and Order Sample Issue Request](#)
- [Submitting Articles](#)
- [International Police Vehicle Design Contest](#)

AGM Battery Technology

Written by Law and Order Staff

Special tires were developed for police work. Special brake pads were developed for police work. There is a special type of battery specifically suited for police work. That battery is labelled "AGM" and it is a perfect match for the duty cycle of police vehicles. There are many kinds of SLI (starting, lighting, ignition) car batteries. Some batteries are very different. However, some differ only by marketing terms. Battery terms like VRLA, vented, maintenance-free, flooded, sealed, AGM, spiral wound, thin plate, pure lead and GEL are easy to confuse. A bit of marketing spin, and it can be very difficult to know what is what. In the broadest terms, there are two basic types of lead-acid car battery: the flooded (or vented) battery and the valve regulated battery. Among the flooded batteries are the old, flooded antimony lead acid batteries from the pre-1970s and the modern, flooded calcium lead acid batteries. The antimony-based batteries required frequent addition of water. The calcium-based batteries, called maintenance-free batteries (or much more correctly called low-maintenance batteries) seldom require the addition of water.



The modern OE battery is the flooded calcium, maintenance-free battery. This is not a Valve Regulated battery. The terms "Valve Regulated" and "Valve-Regulated Lead Acid (VRLA)" are reserved for the SLI batteries that allow for any gas generated by the charging process (hydrogen and oxygen) to be recombined inside the battery back to water. This negates the need for adding any water during the life of the battery.

All these modern batteries are different from the old flooded antimony lead acid batteries used up until the mid-1970s. Those older flooded antimony batteries needed occasional addition of water. Large screw caps on the top of the battery were removed to add water.

Low-maintenance calcium flooded batteries have been steadily replacing the antimony flooded batteries since the mid-1970s. This is a battery that you don't have to check electrolyte levels, since there is only minimal water loss during normal operation and one that cannot be refilled with water or electrolytes. This is still the battery of choice from the factory for virtually all cars, crossovers, SUVs and pickups.

All modern police vehicles come from the factory with some form of flooded low-maintenance battery. The two basic kinds of Valve Regulated batteries are the Gelled Electrolyte Lead (gel) battery and the Absorbed Glass Mat (AGM) battery. What separates these Valve Regulated batteries from the flooded types is that the electrolyte, typically 28 percent sulfuric acid, rather than being a free liquid is held in position either by a silica gel or absorbed in a micro-fiber glass mat (AGM). The original AGM battery dates back to 1974 and the Gates Rubber Company. They replaced the antimony or calcium in starter batteries with very thin pure lead electrodes.

The Gelled Electrolyte Lead acid battery (GEL) uses silica dust in the electrolyte solution. This forms a thick, putty-like gel. This silica helps to recombine the gases given off during charging and discharging. Some AGM batteries, like the spiral-wound Optima, are mistakenly called gel cell batteries. The gel cell battery is not as fast to charge or discharge as the AGM, nor is it a good match for most automotive alternator charging profiles. Since gel cell batteries are so sensitive to recharge rates/voltages, it is unlikely that any fleet manager has given a true gel cell battery a trial in their fleet.

Police-specific Problem

Article Images

Click to enlarge images.



Battery technology has changed dramatically since the 1950s vintage, flooded cell, lead acid batteries. The good news is that today's car batteries are low maintenance with no removable caps to add distilled water. For nearly all retail and fleet applications, the flooded, calcium lead acid, low-maintenance battery is the ideal balance of performance and cost.

The bad news is that today's batteries just cannot be deep cycled (run completely dead then recharged) without shortening their life. On a retail car, this disadvantage doesn't matter. The car itself will shut off lights or other devices that drain the battery. It is rare that a battery is fully depleted on a modern retail vehicle. Not so with a police vehicle. That is a recurring problem for law enforcement vehicles where deep cycle discharges are common due to heavy amp draw even while running and parasitic losses from upfitted gear when not running.

Don't be fooled by the higher alternator output ratings on today's police vehicles. It may have a 220-amp alternator, but the vehicle itself is consuming most of that. Of course, those are ideal output ratings at optimum ambient temperatures and engine rpms. In fact, the car itself may be using 99 percent of whatever the alternator happens to be producing under real-life conditions. If the amp load from upfit devices exceeds that, it comes from the battery.

Deep Cycles Kills OE Batteries

The OE low maintenance, flooded cell, lead acid battery is not the best choice for police use: The police battery is frequently drained below 50 percent, often drained below 80 percent, and sometimes drained completely dead. That different kind of duty cycle calls for a different kind of car battery. They are (of course) more expensive, but they are readily, widely available and they completely solve the deep cycle problem.

Significant for police work, the best AGM batteries can handle hundreds of charge-discharge cycles to 80-percent depth of discharge. No flooded calcium, maintenance-free (low-maintenance) battery can do that, which is why law enforcement goes through so many OE batteries.

Using standardized, deep cycle tests, the flooded, maintenance-free battery will recover the specified "battery charge" and "battery reserve" for about 50 deep cycles. Often times, the OE police battery "needs replaced" as soon as a dozen fully depleted cycles. However, for controlled variable test comparisons, the lab answer is 50 cycles. Under these same test conditions, the conventional calcium AGM battery lasts about 150 cycles. A thin-plate, pure-lead AGM like the NorthStar goes 400 cycles.

Calcium AGM and Pure Lead AGM

That brings us to the true AGM batteries in automotive use. One type is the conventional, thick-plate "calcium" AGM. The other type is the thin plate, "pure lead" AGM. Among the pure-lead AGM batteries are the "flat plate" and "spiral wound" designs. All these AGM batteries are vastly superior to the OE maintenance-free battery in the way law enforcement uses a car battery.

With traditional flooded cell batteries, the positive and negative grids hang in a box submerged in a sulfuric-acid electrolyte solution. With AGM batteries, the positive and negative plates are separated by an absorbed glass mat that holds the electrolyte solution like a sponge. The AGM battery does not contain any free liquid. In fact, it can be installed on its side or even upside down.

The calcium AGM batteries use a thicker plate of lead, perforated to hold the calcium-alloy lead paste. The lead paste is made of lead oxide-lead dioxide, sulfuric acid and water. Calcium in the lead alloy stiffens the flat plate and the plates are thick enough, rigid enough to hold their flatness.

Pure-lead AGM batteries do not use calcium alloyed into the lead plates. These pure lead plates are thinner and there are more of them for the same volume. Since these are tightly squeezed together, and the gap between plates is smaller, the pure lead AGM has a greater lead plate surface area, less internal resistance, and less internal corrosion (oxidation).

Both the calcium AGM and the pure lead AGM begin service life with similar performance. Over time, the pure lead AGM holds two advantages. First, with its lower internal resistance and slower rate of internal oxidation, the pure lead AGM has a longer service life than a conventional calcium AGM.

Second, from a depleted, deep cycle condition, these two AGM battery designs have different service lives. Calcium is corrosive. The calcium AGM oxidizes before the pure lead AGM, i.e., the positive grid internal to the battery corrodes. Calcium AGM batteries lose water faster than a pure lead AGM. This loss of water causes increased internal resistance.

During battery operation, the pastes on the grids react to generate electricity; on discharge, lead dioxide (conductive) on the positive grid converts to lead sulfate (resistive). The reverse process occurs during subsequent recharge; however, since lead sulfate occupies a higher volume than the lead dioxide, it can become electrically detached from the conductive grid and not be recharged. As this lead sulfate layer builds up on the plates, the internal resistance gets high enough that the battery fails.

The thin plate, pure lead AGM starts off with lower internal resistance than the calcium AGM and has a higher compression, which helps to ensure the lead sulfate remains in electrical contact with the grids and aids the recharge, and hence, extends battery life. An additional benefit of the high-compression design, particularly for vehicles that see demanding road conditions, is that it affords AGM batteries greater vibration resistance than their flooded counterparts.

AGM batteries do not sulfate or degrade like flooded acid wet cell batteries. Under most situations, all of the AGM battery designs keep the gases produced during charging inside the battery. There is relatively little gas generated and under normal conditions, the gasses recombine within the battery itself. If the gas pressure exceeds a certain level, the safety valve opens and allows the pressure to bleed off in a short series of "burps."

All versions of these Valve Regulated batteries (calcium AGM, spiral wound AGM, flat plate AGM) use basically the same pressure bleed-off valve concept. Think of it this way: The valve regulates the

pressure with a one-way valve, it does not merely vent gasses out of the battery. The end-of-life characteristics of all these AGM batteries are also a good match for police work. Today's flooded cell batteries simply stop working. The last cranking cycle was just fine. Now the engine won't turn over at all. The failure is immediate, sudden and complete...you are stranded wherever you are. The AGM battery slowly loses power at end of life. There is no catastrophic failure. You can tell from the slower engine cranking that a new battery is needed. Fleet maintenance fact: Any AGM battery is much better for police use than the factory battery. Both the calcium AGM and the pure lead AGM crank longer and are more tolerant of deep cycle drains than OE maintenance-free batteries. That said, there is a performance difference among these two types of AGM battery. Since the thinner plates in the pure lead AGM have more surface area contact than the thicker plates in the calcium AGM, they are more efficient during both discharging and recharging. The calcium AGM is "better" while the pure lead AGM is "best."

Flat Plate and Spiral Wound AGM

There are two types of pure lead AGM. One design of the thin-plate, pure-lead AGM battery is the "flat plate" AGM (NorthStar, Odyssey). The other thin-plate, pure-lead battery design is the "spiral wound" AGM (Optima). The typical flat (thin) plate AGM battery has 15 percent more plate surface area than a spiral-wound AGM battery. The flat plate AGM is denser, heavier and more powerful for the size of the battery than the spiral wound AGM.

The pure lead in the high-end AGM batteries (NorthStar, Odyssey, Optima) is 99.99-percent pure, virgin lead. Higher purity means fewer contaminants and a lower incidence of outgassing. Higher purity lead means extended battery life and increased battery performance. Pure lead plates can be made thinner than lead alloy plates, so more plates can fit into the battery. More plates means more surface area, which means more power.

Arguably, technically, the flat plate AGM (NorthStar, Odyssey) are the "best of the best." However, on the street and in terms of performance (battery capacity, reserve capacity, deep cycle tolerance, service life), the flat plate AGM and the spiral wound AGM are very similar. All are better than the conventional calcium AGM. All are vastly superior to the flooded, maintenance-free factory battery. Bottom line? The way police vehicles are used, the best public safety solution for starting emergency vehicles comes from one of the AGM batteries.

SIDEBAR 1:

Advantages of AGM batteries over maintenance-free batteries

- More deep cycle tolerant
- Longer service life
- Longer cycle life
- Longer shelf life
- Faster recharge recovery
- Vibration resistance
- Extreme temperature tolerant
- Spill proof
- More cranking power
- Higher voltage profile during discharge

SIDEBAR 2:

One Test Worth 1,000 Expert Opinions

JP Magazine, the off-road and rock-crawling enthusiast magazine, conducted a series of battery endurance tests for their 4x4 readers. These tests to complete battery depletion are a perfect match for the way law enforcement uses batteries.

One test was the continuous run of a high-amp boom box, i.e., continuous operation of the audio system until it stopped working. High-performance audio systems are exactly like upfitted police gear: each has an amp draw that often exceeds the alternator output, or each is operated with the engine off. During the test, the current draw was a consistent 40 amps. The score was simply the number of minutes the audio system could be heard.

The NorthStar (flat plate AGM) battery won this steady amp draw test. At 95 minutes, it lasted the longest of any battery tested. In second place was the Odyssey (flat plate AGM) at 92 minutes. The Optima Yellow Top (spiral wound AGM) took third at 84 minutes. The DieHard Platinum (flat plate AGM) lasted 82 minutes. In comparison, the DieHard Gold (flooded, maintenance-free) lasted only 66 minutes.

The second *JP Magazine* test was the distance (in feet) that the battery could power a winch with a heavy load. Specifically, a 12,000-pound rated winch was used to pull a 6,500-pound Jeep up a loose sand hill until the winch stopped pulling. Most of the pulls during this maximum cranking power test lasted four minutes.

The NorthStar (AGM) again placed first at 471 feet. The NorthStar (AGM) was followed by the Odyssey (AGM) at 382 feet, the DieHard Platinum (AGM) at 352 feet, and the Optima Yellow Top (AGM) at 307 feet. In comparison, the DieHard Gold (flooded) winched the load at 295 feet. AGM batteries have longer discharge capabilities. Of all these, the NorthStar clearly beat the other pure-lead AGM batteries both times. A conventional calcium AGM battery was not tested.

SIDEBAR 3:

Confusion at the Auto Parts Store

It is one thing to know what a conventional calcium AGM battery is, or what a thin-plate, pure-lead AGM battery is. It is a whole other thing to figure out which is which at an auto parts store, or even how to tell any of these superior AGM batteries from a very good, flooded, maintenance-free battery. In fact, you probably will not find any of the pure-lead AGM batteries at the local auto parts store. The best way to sort out similar looking batteries with totally different technologies is to do careful online research by private label and brand name.

There are really only three, widely available pure-lead AGM car batteries: the NorthStar/Batteries Plus Bulbs™ X2Power®; the Orbital/Optima; and the Odyssey/DieHard Platinum. The NorthStar is a flat plate, pure lead AGM. It is produced by NorthStar in Missouri. NorthStar only produces the highest-end, pure-lead AGM batteries; no flooded, maintenance-free batteries, no gel cell batteries, and no calcium AGM batteries. If you find any listing for a NorthStar car battery, it is the right one: flat-plate, 99.99-percent Pure Lead AGM. NorthStar also private brands its battery under X2Power®, which is sold through the Batteries Plus Bulbs™ chain of 650 stores.

While NorthStar may be a new name, fleet managers may be more familiar with the other pure-lead AGM batteries: the Optima and the Odyssey. The NorthStar and the Odyssey use a “flat plate” design. The Optima is different. It is a 99.99-percent pure lead AGM that uses a “spiral wound” construction instead of flat plates. It is this spiral wound design that gives the Optima its “six-pack” appearance. The Optima looks so different from conventional batteries that this is the battery frequently—mistakenly—called a gel cell battery. The Optima is not a gel cell battery. Instead, it is a spiral wound AGM. The Spiral Cell Technology uses lead sheets with absorbent glass mat separators wound up in a coil shape. The Optima spiral wound AGM was originally made in the USA. After the Johnson Controls purchased the company, production of the Optima was moved to Mexico.

The Odyssey is a pure lead, thin plate AGM produced by EnerSys. The Odyssey is also private labelled (rebranded) as the DieHard Platinum, sold by Sears. The Odyssey and DieHard Platinum are essentially exactly the same flat-plate AGM battery. The NorthStar and the Odyssey are similar in many ways. Both are flat (thin)-plate AGM batteries. Both use 99.99-percent lead. Both are made in the USA.

Conventional Calcium AGM

East Penn makes a lot of conventional, calcium AGM batteries. At Auto Zone, the DuraLast Platinum is a calcium AGM, while the DuraLast Gold is a flooded, maintenance-free battery. At NAPA, the Legend is a calcium AGM. At O'Reilly, the Super Start Platinum is a calcium AGM.

Among DieHard batteries, the DieHard Gold is a flooded, maintenance-free battery, the DieHard Advanced Gold is a calcium AGM battery, and the DieHard Platinum is a thin plate, pure lead AGM battery. In fact, the DieHard Platinum is a rebadged, private-label Odyssey AGM battery.

Price definitely separates the flooded, maintenance-free battery from the calcium AGM and again from the pure lead AGM. The calcium AGM is more expensive than the flooded, maintenance-free battery and the pure lead AGM is more expensive than the calcium AGM. Think \$250 to \$275 (MSRP) for a pure lead AGM. However, also think total cost of ownership.

With one of the AGM batteries, you will probably not have to replace the battery in that vehicle again. In addition to more replacement batteries you won't have to buy, there will be fewer jump starts (and PCM reprogramming), fewer in-service tows, and less overall vehicle downtime. The most downtime-focused fleet managers are having their upfitters, including the factory upfitters, install an AGM battery during the initial upfitting.

Published in Law and Order, Apr 2015

Rating : 10.0

Comments

[Comment on This Article](#)

No Comments

Related Companies

DieHard

EnergySys

Johnson Controls

NorthStar

Related Products