

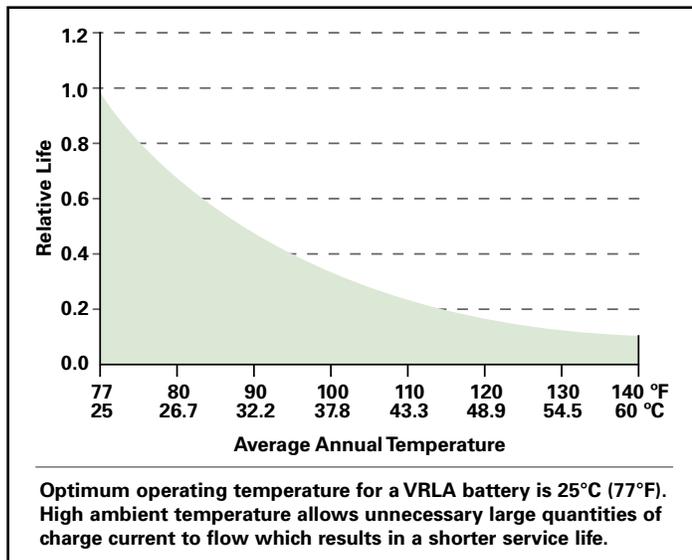
Single-phase battery

Four factors that affect battery life

Batteries have limited life, usually showing a slow degradation of capacity until they reach 80 percent of their initial rating, followed by a comparatively rapid failure. Regardless of how or where a UPS is deployed, and what size it is, there are four primary factors that affect battery life: ambient temperature, battery chemistry, cycling and service.

1. Ambient temperature

The rated capacity of a battery is based on an ambient temperature of 25°C (77°F). It's important to realize that any variation from this operating temperature can alter the battery's performance and shorten its expected life. To help determine battery life in relation to temperature, remember that for every 8.3°C (15°F) average annual temperature above 25°C (77°F), the life of the battery is reduced by 50 percent.



2. Battery chemistry

UPS batteries are electrochemical devices whose ability to store and deliver power slowly decreases over time. Even if you follow all the guidelines for proper storage, usage and maintenance, batteries still require replacement after a certain period of time.

3. Cycling

During a utility power failure, a UPS operates on battery power. Once utility power is restored, or a switch to generator power is complete, the battery is recharged for future use. This is called a discharge cycle. At installation, the battery is at 100 percent of rated capacity. Each discharge and subsequent recharge reduces its relative capacity by a small percentage. The length of the discharge cycle determines the reduction in battery capacity.

Lead-acid chemistry, like others used in rechargeable batteries, can only undergo a maximum number of discharge/recharge cycles before the chemistry is depleted. Once the chemistry is depleted, the cells fail and the battery must be replaced.

4. Maintenance

Battery service and maintenance are critical to UPS reliability. A gradual decrease in battery life can be monitored and evaluated through voltage checks, load testing or monitoring. Periodic preventive maintenance extends battery string life by preventing loose connections, removing corrosion and identifying bad batteries before they can affect the rest of the string.

Even though sealed batteries are sometimes referred to as maintenance-free, they still require scheduled maintenance and service. Maintenance-free simply refers to the fact that they don't require fluid.

Without regular maintenance, your UPS battery may experience heat-generating resistance at the terminals, improper loading, reduced protection and premature failure. With proper maintenance, the end of battery life can be accurately estimated and replacements scheduled without unexpected downtime or loss of backup power.

Battery life: design life vs. actual life

Determining battery life can be a tricky business. It's often promoted based on design life, defined as how long the battery can be expected to perform under ideal conditions.

Estimating actual battery life relies on taking into consideration the four factors that can impact affect it.



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What can go wrong with batteries?

Condition	Cause
Plate separation	Repeated cycling (charging and discharging), damage during handling and shipping, and overcharging
Grid corrosion	Normal aging, operating in an acidic environment and high temperatures
Internal short circuit	Heat (plates expand causing shorts), separator failure, handling and shipping, and grid corrosion
External short circuit	Human error (shorting terminals) and leaks
Sulfation of plates	Sitting discharged for an extended period, not on charge or being undercharged
Excessive gassing	Often due to high temperatures or overcharging
Drying out	Excessive gassing, high temperatures or overcharging

Battery disposal

Batteries that are replaced can still contain a significant amount of hazardous waste, including the electrolyte and lead. Therefore, you must comply with EPA guidelines for the disposal of all UPS batteries. There are essentially two main categories of disposal, one for spent batteries and another for spills. The primary ways to handle these two categories are:

Spent batteries

Send to secondary lead smelter for recycling.

Spilled batteries

Place neutralized leaked material into sealed containers and dispose of as hazardous waste, as applicable. Large water-diluted spills, after neutralization and testing, should be managed in accordance with approved local, state and federal requirements. Consult your state environmental agency and/or the EPA.

Recycling

One of the most successful recycling efforts in the world is for lead-acid batteries. According to Battery Council International, more than 96 percent of lead-acid batteries were recycled between 1997 and 2001. Many states require lead-acid batteries be recycled, and several options exist to dispose of used batteries, including:

- If you're engaged with Eaton on a battery upgrade or replacement, we'll take your old batteries and recycle them for you.
- If you participate in Eaton's UPSgrade program, we take the old UPS and recycle it. Visit Eaton.com/upsgrade for details.
- Check your local phone book for a local recycler, or search for a recycler at www.earth911.com.
- Some automotive stores accept batteries for recycling.
- Many municipalities have dump or recycling locations that will accept batteries for recycling. When disposing of batteries in this manner, be sure to get a dated receipt clearly detailing what batteries were dropped off, including quantities with the recycler's full name, address and phone noted in the unlikely event you get audited.

Battery maintenance for extended life

Quantifying the combined effect of the four factors that affect battery life discussed in the previous page is difficult. You need a way to determine when a battery is near the end of its useful life so you can replace it while it still works, before the critical load is left unprotected. The only sure way to determine battery capacity is to perform a battery run-down test. The module is taken off line, connected to a load bank and operated at rated power until the specified runtime elapses or the unit shuts down due to low battery voltage. If battery capacity is less than 80 percent of its rated capacity, the battery should be replaced.

Thermal scanning of battery connections during the battery run-down test identifies loose connections. This test gives you the chance to see the battery during an extended, high-current discharge. Scanning should take place during discharge and recharge cycles.

An effective UPS battery maintenance program must include regular inspections, adjustments and testing, with thorough records kept of all readings.

Spot replacement of batteries

Batteries in series are similar to a string of holiday lights. When one unit fails, the entire string no longer works. When a battery or group of batteries connected in a series ceases to work, not only is the battery string no longer functional, but it can be difficult to determine which battery has failed.

The most effective way to combat this potential problem is to "spot" replace bad batteries that are less than three years old. While the four factors affecting battery life play a large role in determining when a battery is vulnerable to failure, there's no precise way to ensure that battery failure can be predicted. The only way to identify bad batteries early enough for spot replacement is through continuous battery monitoring and scheduled maintenance. Spot replace bad batteries that are less than three years old and replace the whole string between the fourth and fifth year.

Lead-acid batteries: good for the environment?

Which commonly used product has the highest rate of recyclability? Paper? Only 73 percent of paper is recycled for reuse. Aluminum at 54 percent and glass at 25 percent also fall short of the leader. More than 96 percent of all battery lead is recycled. Lead-acid batteries top the list of most highly recycled consumer product.

The processes for lead-acid battery recycling support agriculture needs and enhance energy conservation. Beyond the successful reuse of nearly 100 percent of the battery components, lead recycling facilities harness radiant heat from their furnaces to offset traditional heating costs. Residual sulfur trapped during recycling is processed into fertilizer. Even the plastic casings are crushed into pellets and are used to manufacture new battery covers and cases. Recycling lead is also more energy efficient than smelting or mining new lead. The recycled lead can be refined into new alloy repeatedly, giving it unmatched sustainability and cost stability—a trait unlike most raw materials.

Battery FAQ

1. What is the “end of useful life”?

The IEEE defines “end of useful life” for a UPS battery as being the point when it can no longer supply 80 percent of its rated capacity in ampere-hours. When your battery reaches 80 percent of its rated capacity, the aging process accelerates and the battery should be replaced.

2. What about battery disposal?

It's imperative that your service technicians adhere to EPA guidelines for the disposal of all UPS batteries. Remember, it's the owner's responsibility to make sure these guidelines are followed.

3. My UPS has been in storage for over a year. Are the batteries still good?

As batteries sit unused, with no charging regimen, their battery life will decrease. Due to the self-discharge characteristics of lead-acid batteries, it's imperative that they're charged periodically during storage or permanent loss of capacity will occur. To prolong shelf life without charging, store batteries at 10°C (50°F) or less.

4. What is the difference between hot-swappable and user-replaceable batteries?

Hot-swappable batteries can be changed out while the UPS is running. User-replaceable batteries are usually found in smaller UPSs and require no special tools or training to replace. Batteries can be both hot-swappable and user-replaceable. Please check your user's guide for details on your UPS batteries.

5. How is battery runtime affected if I reduce the load on the UPS?

The battery runtime will increase if the load is reduced. As a general rule, if you reduce the load by half, you triple the runtime.

6. If I add more batteries to a UPS can I add more load?

Adding more batteries to a UPS can increase the battery runtime to support the load, but it doesn't increase the UPS capacity. Be sure your UPS is adequately sized for your load, then add batteries to fit your runtime needs.

7. What is the average lifespan of UPS batteries?

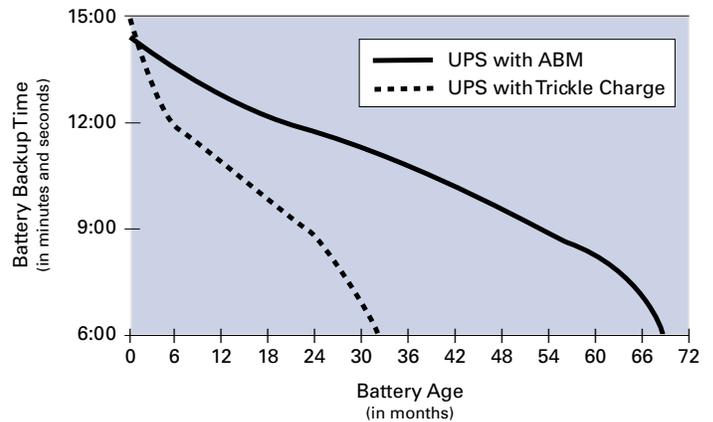
The standard lifespan for VRLA batteries is three to five years; for wet-cell batteries it's up to 20 years. However, expected life can vary greatly due to environmental conditions, number and depth of discharge cycles, and adequate maintenance. Having a regular schedule of battery maintenance and monitoring will ensure you know when your batteries are reaching their end-of-life.

8. Why are batteries disconnected on small, single-phase UPSs when they're shipped?

This is so that they're in compliance with Department of Transportation regulations.

Extending battery service life

Eaton's ABM® technology uses a unique three-stage charging technique that significantly extends battery service life and optimizes recharge time compared to traditional trickle charging. An integrated battery management system tests and monitors battery health and remaining lifetime and provides advance notification to guide preventive maintenance. Optional temperature-compensated charging monitors temperature changes and adjusts the charge rate accordingly to properly charge the battery and greatly extend battery life. With remote monitoring of the UPS and battery system, Eaton is able to respond to alarms and real-time battery data to avert potential battery problems.



Although batteries are sold with a variety of published life spans, the fact is, some demonstrate a useful life of as little as three to five years. Eaton's exclusive ABM technology significantly increases the life of UPS batteries.

Learn more at
powerquality.eaton.com

Eaton Corporation
Electrical Sector
8609 Six Forks Road
Raleigh, NC 27615 U.S.A.
Toll Free: 1.800.356.5794
Eaton.com

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