



Battery Shelf Life

Dependable Power Solutions, When Failure Is Not an Option.

A Technology White Paper – July 2012



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BACKGROUND

NOVA Power Solutions has been providing uninterruptible power supplies and other power protection products to the US Navy and other Armed Forces since 1998. Our products provide power conditioning and battery backup capabilities to mission critical C4I systems in all branches of the US Military.

To ensure the warfighter receives the highest quality products meeting strict military standards, we work very closely with the system integrators during system design *and* the various support activities after product has been delivered.

Charts from the EnerSys NPX Data Sheet/Range Summary US-NPX-RS-001 may be provided in this paper as reference and can be found online at www.enersys.com. We have exclusively used EnerSys NPX-25 batteries in our replacement battery pack assemblies since the 1990's. Battery characteristics, including shelf life, may vary based on battery manufacturer and type, so we'll only discuss characteristics of the NPX Series UPS in this paper.

DEFINITION: SHELF LIFE

Shelf life is the term or period during which a stored commodity remains effective, useful, or suitable for consumption¹. For rechargeable batteries, this is defined as the *period between recharge cycles*.

DEFINITION: CYCLE SERVICE LIFE

Cycle service life refers to the total number of discharge cycles you can expect to get from a rechargeable battery. This can also be referred to as the "life time" of the battery.

SCOPE

The purpose of this paper is to provide a shelf-life recommendation for our replacement battery pack assemblies, and explain how shelf-life is determined based on manufacturer recommendations and our own historical experience servicing primarily the US Navy the past 20+ years.

¹ www.dictionary.com

Valve Regulated Lead Acid (VRLA) or Sealed Lead Acid (SLA) batteries are considered a consumable product with a shelf life whose performance is affected by four main factors:

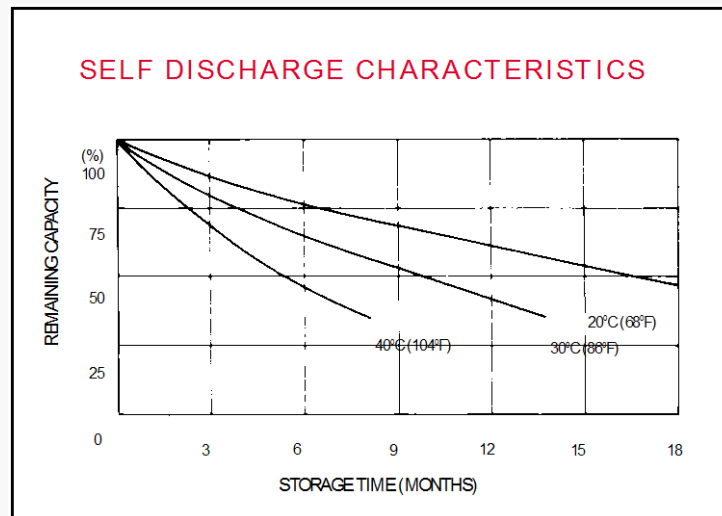
1. Storage temperature
2. Depth of discharge
3. Charge voltage and current
4. Number of discharge cycles

To ensure peak performance care should be taken to follow the manufacturer's recommendations on shelf life based on these four factors.

While we can control *depth of discharge* and *charge voltage and current* through our microprocessor-controlled uninterruptible power supply, *storage temperature* and *number of discharge cycles* are controlled by the storage facilities/warehouses receiving our product after shipment, and the end-user.

STORAGE TEMPERATURE

The single biggest factor affecting shelf life is storage temperature. The chart below depicts remaining capacity in months as a function of storage temperature of the EnerSys NPX Series battery. Battery capacity decreases faster at higher temperatures slower at lower temperatures.



Our replacement battery pack assemblies are fully-charged prior to shipment in an air-conditioned manufacturing facility. Shipping will take less than one week to any CONUS location². Therefore, our replacement battery pack assemblies will still be near fully-charged upon initial receipt.

² NOVA Power Solutions only ships CONUS (Contiguous United States)

In our experience, not all of the facilities that receive and store our replacement battery pack assemblies are capable of maintaining low storage temperatures and are mostly located in warm climates. Further, after delivery from the storage facility to the end-user, it is uncertain how much longer the batteries may sit in storage before being installed in an UPS.

We do not consider many of the storage facilities our batteries are shipped to as representing normal conditions with temperatures in excess of 90-110°F. At such high temperatures a battery pack can completely discharge in less than 9 months.

For these reasons NOVA Power recommends our replacement battery packs are stored no longer than 3-6 months. If storage for longer than 3-6 months is required, NOVA Power recommends providing a “top-off” charge every 3-6 months to provide another 3-6 months of storage³.

If our replacement battery packs are not charged every 3-6 months, self-discharge below the safe low-voltage cut-off can occur, permanently affecting battery capacity.

DEPTH OF DISCHARGE

To ensure the battery packs used in our UPS products are not discharged below safe levels, our microprocessor-controlled circuit board cuts off the batteries during discharge when they reach approximately 1.75 volt/cell, or 10.5VDC per individual 12VDC battery.

VRLA or SLA batteries are different from other rechargeable batteries in that if they are allowed to fall below a certain low-voltage cut-off their capacity can be permanently damaged and may not be recoverable. This low-voltage cut-off threshold is generally accepted as between 1.67 or 1.75 volts/cell, or approximately 10.5VDC per individual 12VDC battery.

Allowing a SLA battery to sit below 1.75VDC per cell for as short as a couple weeks, depending on storage temperature, can permanently affect battery capacity. Therefore, we should always keep VRLA or SLA batteries near fully-charged, and batteries should always be completely recharged following a discharge cycle.

CHARGE VOLTAGE AND CURRENT

VRLA or SLA batteries require a charge voltage of above approximately 13VDC at 20°C to 25°C to accept a charge current. If the charge voltage of a SLA battery is allowed to exceed the gassing voltage of around 14.5VDC, hydrogen gas will be expelled from the battery affecting battery capacity.

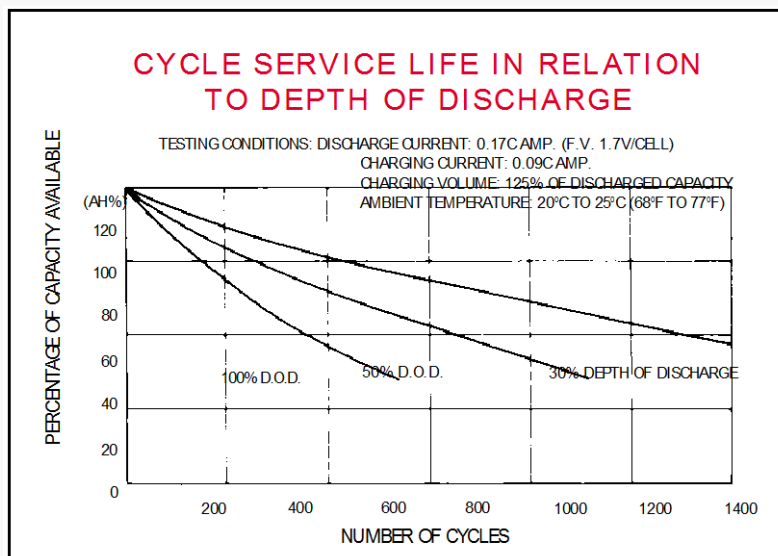
³ We can provide recommendations on a charging station if interested

Charging current should also be controlled to ensure the battery is charged at a safe level and reaches a full charge.

The charging voltages and currents in our microprocessor-controlled charging circuit were selected at the manufacturers recommendations and are considered appropriate and safe.

NUMBER OF DISCHARGE CYCLES

Number of discharge cycles means how many times the battery is discharged over its lifetime. This varies for every user depending on the number of electrical outages or disturbances, the number of preventative maintenance drills, and whether the battery is fully-discharged, or not, during a discharge cycle.



In our experience, if proper care is taken to ensure operation temperature is kept between 20°C to 25°C (68°F to 77°F) the end-user can expect to see between 300-500 discharge cycles, or between 3-5 years under normal conditions.

After this many cycles the battery capacity may be reduced below levels that meet system requirements for battery hold-up time. To ensure system hold-up times are met, and taking into account the availability of replacement battery packs while at sea, we recommend proactively replacing our battery packs every 2-3 years.

CONCLUSION

To ensure proper runtime and lifetime requirements of the battery packs used in our UPS products are met, NOVA Power recommends a 3-6 month shelf life for all of our replacement battery pack assemblies.

NOVA Power has worked closely with various US Navy support entities for 20+ years, receiving feedback on battery usage and tailoring our methods and features to best support the modern warfighter. Our recommendation is made based both on the manufacturers recommendations, and our own long history of understanding and supporting the US Military.

Storage for longer than this recommended shelf life can permanently damage battery capacity, affecting the performance of our uninterruptible power supplies, and therefore the entire system performance.

Additional information can be found on the NOVA Power website at:

<http://www.novapower.com/technologies/batteries.html>