

Uninterruptible power supplies installed in harsh environments

Michael A. Stout, V. P. of Engineering, Falcon Electric, www.FalconUPS.com

What should you pay for a wide-temperature UPS?



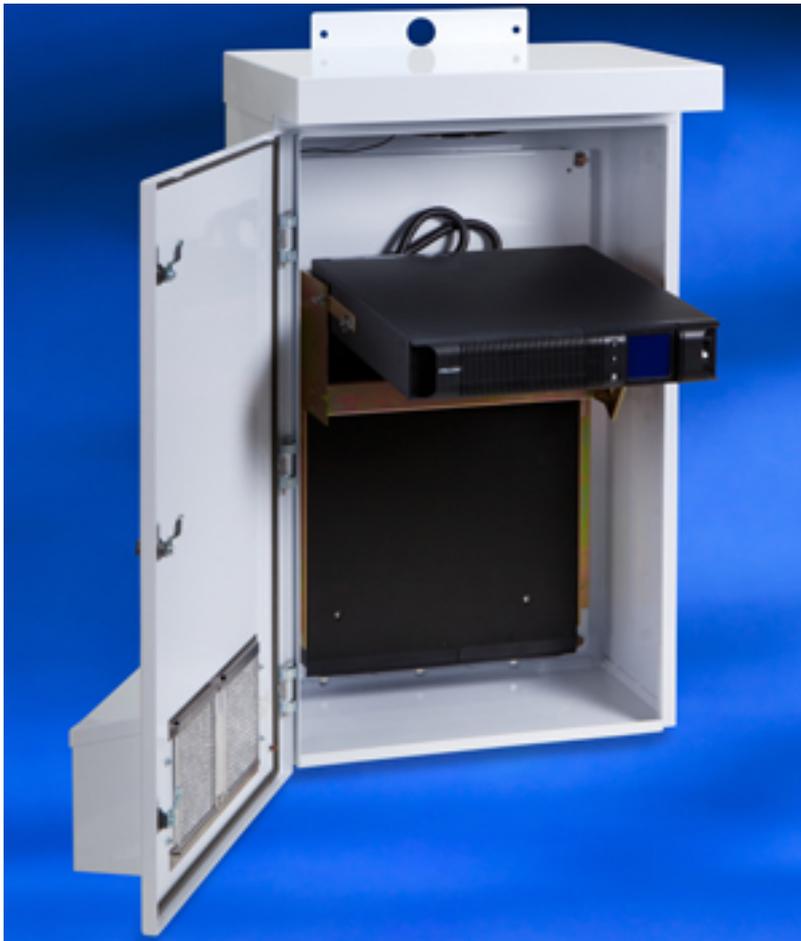
When it comes to power protection, uninterruptible power supplies (UPS) to be specific, most think of these systems tucked away in an environmentally controlled environment, quietly at the ready to protect against any power problems that may come their way. Due to the integration of power-sensitive microprocessor controllers into every type of device and equipment imaginable, on-line UPSs are required to not only provide battery backup but to act as a firewall between questionable utility power and the power-sensitive equipment. The active power regenerating capabilities of on-line UPSs supplies provides the connected equipment with continuous, clean computer-grade power. Often, the equipment has to be installed in a variety of environmentally demanding locations, requiring the UPS to handle wide temperature swings while maintaining excellent reliability.

Not any UPS will do

The operational temperature specifications for the majority of UPS models being offered by most UPS manufacturers is typically stated as 0°C to 40°C and the UPS has been designed to operate within that range. Typically, the UPS manufacturer has submitted a sample of the UPS to a safety agency such as Underwriters Laboratories (UL) for testing so they will receive a Listing approval for operation within the stated temperature range. However, equipment may be

Uninterruptible power supplies installed in harsh environments

Published on Electronic Component News (<http://www.ecnmag.com>)



installed in a remote or protected outdoor environment having a wider temperature range. In these applications, the temperature may range from -30°C to 65°C (-22°F to 149°F) inside protective NEMA enclosures (Figure 1) or a building without temperature control. A standard off-the-shelf UPS is designed specifically for use in an indoor, temperature-controlled environment. When UPS specifications are reviewed, they typically indicate that the UPS has received a UL listing status under the UL1778 standard. This usually indicates that all UL product safety and component thermal testing were performed within the stated 32°F to 104°F temperature range, unless otherwise specified by the manufacturer.

As part of the UL thermal testing, the UL engineer verifies that component temperatures are within the limits specified by the component manufacturer of the UL1778 standard. This includes the temperature ratings of the key electronic components, displays, plastics, circuit board materials, insulating materials, magnetics, batteries and everything used in the construction of the UPS. Elevating the ambient temperature the UPS has been installed in stresses the components and may result in the UPS's internal components to overheat and affect its reliability.

This is the key to understanding why the off-the-shelf UPS products should not be installed in non-temperature controlled locations that are outside the manufacturer's stated operational temperature range.

Batteries - The weak link

The majority of UPS products rated under 10kVA use valve regulated sealed lead-

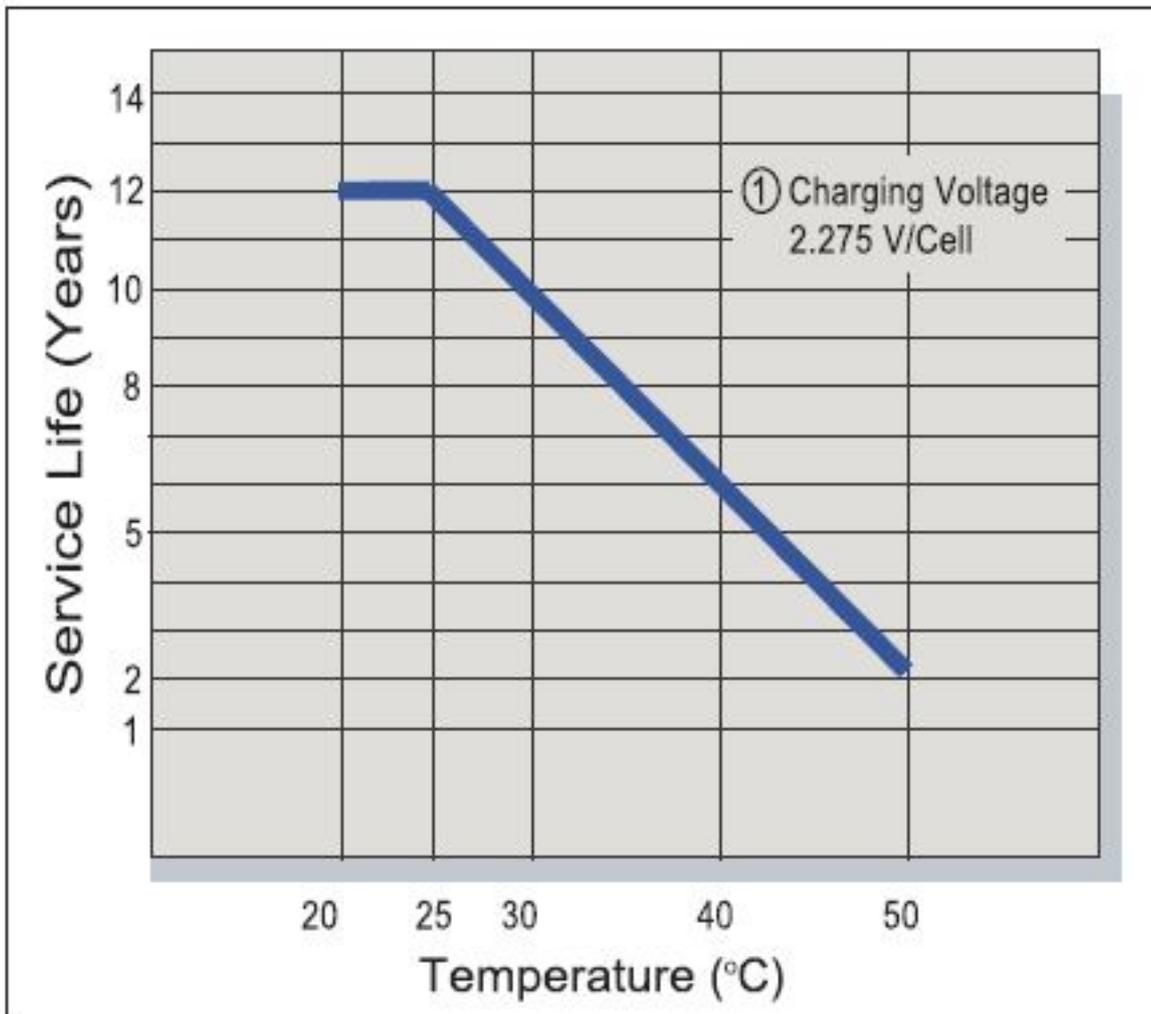
Uninterruptible power supplies installed in harsh environments

Published on Electronic Component News (<http://www.ecnmag.com>)

acid (VRLA) batteries to provide backup energy. Due to identical battery chemistries and like construction, most battery manufacturers' specifications are very similar. Battery manufacturers rate their projected battery life with the battery operating in a 25°C environment. They provide graphs that show the reduction in battery life as the ambient operating temperature increases.

As shown in the graph (Figure 2), a nine-month battery life is projected when operated in a 50°C environment, while projecting a five-year life at 25°C.

Trickle (or Float) Service Life



Other batteries with very wide temperature ranges are available, but due to their high cost are not typically installed in most commercial off-the-shelf (COTS) UPS products.

Let's take a closer look at the operational temperature range of a typical VRLA battery used in a COTS UPS unit.

- Discharge mode (+5°F to +122°F)
- Recharge mode (+5°F to +104°F)
- While being stored (+5°F to +104°F)

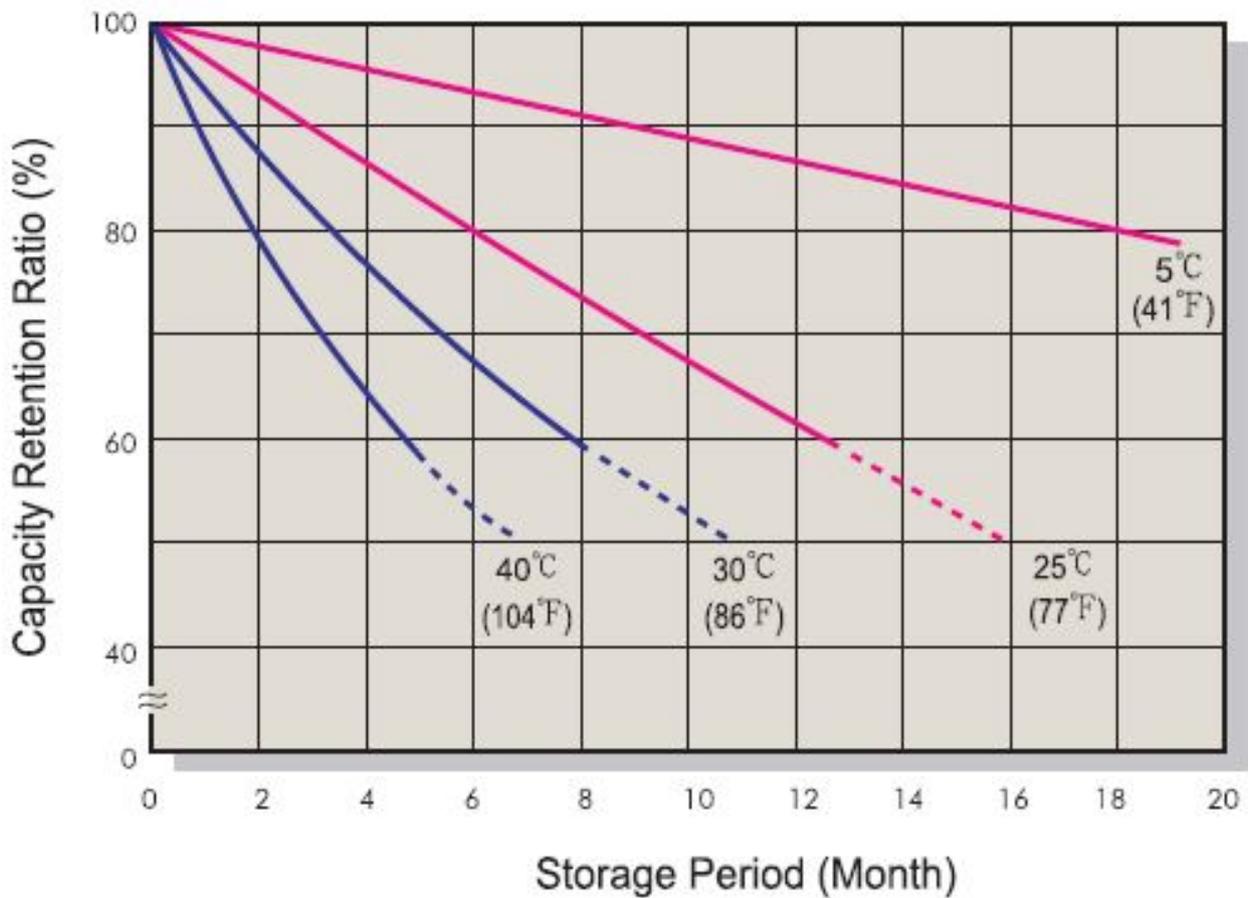
Uninterruptible power supplies installed in harsh environments

Published on Electronic Component News (<http://www.ecnmag.com>)

- Battery plastic material (140°F Max)

It's clear that the battery manufacturer's stated operational temperature ranges are not wide enough for use in a -22°F to +149°F application

Newer technology VRLA batteries yield a four year of life at 50°C and up to 12 years at a 25°C room temperature. Proper charge and recharge of the batteries must be maintained to assure the stated battery life. If stored without recharging, VRLA batteries used in UPSs will self-discharge at a given rate over time. If allowed to discharge to a level below 60% depth of discharge, irreversible damage will occur inside the battery. The damage is caused by deposition of lead sulfate on the surface and in the pores of the active material of the batteries' lead plates. High ambient temperatures accelerate this process as they make the chemistry more active. The Capacity Retention chart (Figure 3) shows the effects of the ambient storage temperature on the rate of self-discharge.



Assuming the battery was fully recharged when stored at 77°F, it is recommended that it be recharged every 12 months. If stored in a 104°F environment, the battery must be recharged every five months. Failure to keep the UPS batteries properly charged is the number one cause of premature battery failure. Often a UPS is unplugged with its batteries in a discharged state for several months when not in use. The lack of charge and battery self-discharge, combined with any low level current demanded by the UPS, causes the batteries to become excessively discharged.

Not all components are created equal

Semiconductor manufactures often grade like part number components for use in differing operational temperature ranges. The wider the operational temperature range, the more the component costs. The UPS business is very competitive. As such, semiconductors and other components used in their manufacture are selected due their suitability for operation within the specifications of the UPS with an eye on their cost. For instance, many Integrated Circuits (ICs) have differing temperature grade ratings with 85°C the standard recommended upper operational temperature. Most off-the-shelf UPS products are manufactured using this grade of ICs. When subjected to higher temperatures, their reliability often decreases causing a premature failure of the UPS. Wide-temperature UPS manufacturers typically use ICs rated for use at 125°C greatly increasing the UPS reliability when subjected to elevated ambient environment temperatures.

Many other considerations must be taken when designing a wide or high temperature UPS. Component and plastics ratings along with increasing the overall UPS efficiency and cooling are key to developing a much more robust UPS suitable for use in harsh temperature environments. Of course the wide-temperature UPS must pass the same rigorous safety agency testing of its off-the-shelf counterpart and receive the same Listing status, except the testing is conducted over the wider stated operational temperature range. The operation temperature range and safety agency listing status for a UPS is either printed on a label located on the UPS rear panel, or stated in the UPS specifications. Using a UPS or any other piece of electronic equipment outside its rated operational temperature not only will reduce its reliability, but could present product liability problems for a company.

The simple fact is you get what you pay for. Due to the higher cost of components and batteries, the wide-temperature UPS costs more than a typical off-the shelf UPS. However, the added cost is often offset by its increased reliability, longer battery life and reduced servicing, downtime and product liability. The simple fact is that you should never use a UPS that is not rated for the temperature environment of its intended installation. If you're designing an electrical installation or installing a UPS in an extreme operating temperature environment, select the one that is rated for operation in that temperature range.

Source URL (retrieved on 09/19/2014 - 6:03pm):

<http://www.ecnmag.com/articles/2013/03/uninterruptible-power-supplies-installed-harsh-environments>