NEC ENERGY SOLUTIONS

Performance & Service Life Advantages of the ALM® 12V7s in UPS Systems

SUMMARY

Uninterruptable power supplies (UPS) are critical in supporting computing tools in harsh industrial operations. UPS systems have long depended on lead-acid batteries to serve as a backup energy source.

Increasingly, batteries used in UPS systems need to deliver high power over short run times of two minutes to an hour. Traditional lead acid batteries, even those optimized for high power performance, are challenged in these applications due practical limits on usable capacity versus their nameplate ratings, and a short service life in harsh industrial environments.

The ALM® family of lithium-ion batteries is well suited for these applications, offering greater usable capacity and longer service life. They provide higher reliability and reduce the total cost of ownership. They are more than 50% lighter in weight than equivalent lead acid batteries.

KEY TRENDS

Industrial organizations are utilizing more information technology in facilities located in remote locations that have harsh operating conditions and limited availability of reliable energy sources. The computing and UPS systems are used in industrial factory floors, oil and gas infrastructure, industrial and commercial processing plants, marine locations, and remote monitoring sites. These applications have temperature and other environmental extremes that a typical IT UPS solution cannot support, requiring a specialized industrial UPS system.

Battery technologies utilized in traditional IT systems are not designed for industrial applications. Consequently, most lead-acid batteries are no longer usable in these environments, and when used often need replacement in two years or less. Industrial UPS users seek better battery reliability, performance, and service life to reduce potential downtime of IT systems and cost of servicing. As a result, Industrial UPS suppliers are adopting lithium-ion batteries as safe, durable, and long service life solutions.

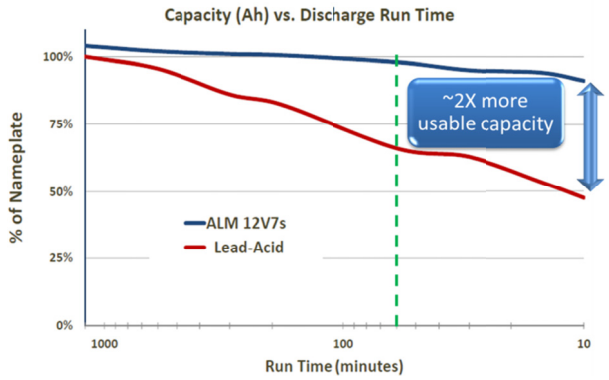
BACKUP POWER ATTRIBUTES & CHALLENGES

Battery arrays used in industrial UPS systems provide power when a primary energy source or grid becomes unavailable. It provides “a bridge” to back up, or power for orderly shutdown of equipment. Usable capacity and energy are critical and are impacted by the load, discharge rate (or run time), temperature, and allowable depth of discharge (DOD) of the battery. Industrial UPS systems are increasingly targeting short run times, often as low as 10 minutes, requiring the battery to discharge all its energy within this short timeframe (i.e. a “6C” rate). The nameplate capacity of most lead-acid batteries assumes energy discharge over a 20 hour time period. At high discharge rates, the actual capacity of lead-acid batteries is significantly less than their rated nameplate capacity. The shorter the discharge time is, the smaller the available capacity and energy. This is due to the Peukert Effect[1], which is an increase in the internal resistance of the battery cells when the discharge current increases. This effect is especially strong in lead acid batteries. For example, the available capacity for a power-optimized lead acid battery require a capacity derating of greater than 50% for a 10 minute run time. To overcome this, a battery array must be oversized by greater than 2X to provide sufficient capacity. This leads to extra cost, size, and weight to the system.

The ALM® family of lithium ion batteries is far less impacted by the Peukert Effect. Their capacity is nearly independent of the discharge current and run time. For example, the ALM 12V7s HP can deliver its full capacity over a 10 minute run time without any capacity derating.

Typical power outage events require a DOD of 50% or more of a batteries’ capacity. While an outage event maybe infrequent in stable grid environments, DOD of 50% or more may significantly reduce the service life of lead-acid batteries. In weak or off grid environments, with frequent power cycling and deep DOD > 80%, the reduction in service life is even greater. The ALM family of lithium ion batteries delivers cycle life of over 10,000 cycles even with a 100% DOD. Additionally, the internal battery management system (BMS) limits damaging over-discharge of the ALM, providing a robust battery under the toughest applications.

The combination of deep discharges, high discharge rates (short run time) and temperature extremes add up to significantly shorten the service life of lead acid batteries in most industrial UPS applications to two years or less. The ALM® family delivers high power cycling performance, durability, safety, and long service life greater than 10 years. While the initial cost of lithium ion batteries may exceed lead-acid batteries, the extended service life and high power delivery provide a lower total cost of ownership.



COMPARING BATTERY ARRAY POWER SYSTEMS

Using typical requirements for a small industrial UPS in bridge-to-backup applications, NEC Energy Solutions' compares its ALM® 12V7s HP battery against a well-known lead-acid battery, optimized for high power applications. The operating period is 10 years.

System: 1100 VA, 0.74 kW

Battery Run Time: 12 minutes @ 500W

Battery String Voltage: 36V nominal

Operating temp: 0 °C to 50°C, average 35 °C

Configuration: 2U rack-mount UPS

Metric	ALM	Lead-Acid	Unit
Target System Size (Energy)	100		Wh
Target Power Delivery	500		W
Implied Discharge Duration	0.20		Hours
Target Temperature Range	0 to +50		°C
Nameplate Capacity (per Battery)	5	7	Ah
Capacity @ target rate	5	3	Ah
Energy (@ target rate)	59	36	Wh
Temperature capacity derating	10%	20%	%
Safe DOD level	100%	100%	%
Usable Energy per battery	53	29	Wh
# Batteries	3	3	#
Total Usable Energy	159	86	Wh
Expected Service Life	10	2	years
Number of Replacements	0	4	
Total Weight (kg)	2.7	7.8	kg

SOLUTION

The ALM 12V7s HP uses lithium iron phosphate (LiFePO4) cells that provide excellent deep cycling capabilities, extended temperature, long service life and exceptional power and energy performance. The ALM 12V7s family includes EverSafe™ protection technology as part of the Battery Management System (BMS) in each battery. This technology delivers fully redundant protection from internal failures or external abuse. It provides system-level protections for battery strings and power system operation, with automatic adjustments and recovery from system level faults or abusive application.

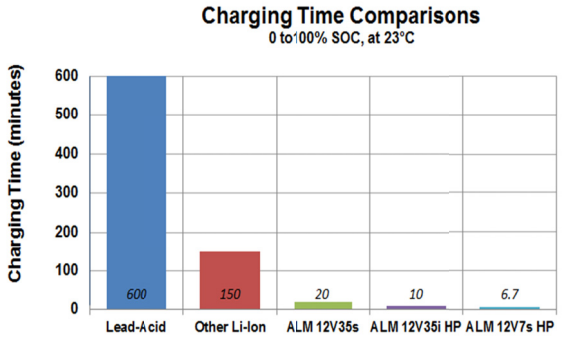
The ALM 12V7s HP has a number of advantages.

1.) Excellent high power, short run time performance
Preventing an outage demands full power from an UPS when switching to a backup energy source. The ALM 12V7s HP delivers 100% DOD (Depth of Discharge) over the 12 minute run time with minimal derating of its usable capacity. Three ALM 12V7s HP when combined provide 159Wh of useable energy, even after a 10% temperature derating is applied. This solution has plenty of capacity and margin for the application.

The 12V, 7Ah high-power optimized lead-acid battery at 100% DOD requires a 57% derating to 3Ah, or 36Wh of usable energy per battery. Taking into account temperature derating, the three lead-acid battery array is 14% below the system energy target of 100Wh. Since the requirement is for a 2U rack mount enclosure, it is unlikely there is extra space to add capacity from three extra batteries in parallel, or to use three higher capacity 12V batteries.

2.) Service Life, Total Cost of Ownership
The ALM 12V7s HP has a service life of greater than 10 years at an average temperature of 35 °C, and the occasional 100% DOD in 12 minutes. The high-power optimized lead-acid battery service life under these conditions is two years or less. Over a ten-year period, the lead-acid battery array needs to be replaced four times in order to provide the power back up needed from the UPS system. This increases the total cost of ownership, due to servicing and replacement. The ALM 12V7s HP requires no replacement over this time period, eliminating service and replacement costs.

3.) High current chargers: Weak/Off grid applications
For UPS systems in weak or off grid installations, high current chargers can be used to insure full capacity and availability of the battery array. The ALM 12V7s product family can take advantage of high current chargers, with minimal impact on service life. The ALM 12V7s HP battery can be fully charged from 0% to 100% in <7 minutes. The ALM 12V7s, a lower power battery, can be fully charged in just 15 minutes.



4.) **Significantly less weight than lead-acid batteries.**
The low weight of the ALM 12V7s HP eases installation, with each battery only 0.9kg. For remote or hard to reach locations, this is essential. Three ALM batteries are just 2.7kg. The 3 lead-acid batteries are 7.8kg or 3X heavier.

NEC Energy Solutions ALM® family of lithium-ion batteries undergo engineering construction, evaluation, and extensive testing to ensure international product safety conformity, as well as application specific certifications.

Visit **www.neces.com** for the latest information and data sheets.

Note1: From Peukert's law, presented by the German scientist W. Peukert in 1897, expresses the capacity of a battery in terms of the rate at which it is discharged.