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5.1.3 Reliability

In most cases, the reliability of a VLA is better than VRLA cells given similar environments. VLA batteries are also more robust to environmental conditions such as temperature and ripple current (see 6.2.2). Ni-Cd cells have similar reliability to VLA batteries. Ni-Cd cells may perform better than VLA in applications with temperature extremes.

5.4.2 Thermal management

Maintaining the operating temperature of the battery at 20 °C to 25 °C will maximize its service life and efficiency.

Normal charging of a vented cell results in very little heat evolution. The small amount of heat produced is readily dissipated through the bulk of the liquid electrolyte or with evolved gas. Although heat may be evolved under fault conditions (e.g., overcharging with low electrolyte levels), the primary concern under such conditions is normally hydrogen removal rather than thermal management.

When a VRLA cell is operating at float or overcharge in a fully recombinant mode, there is virtually no net chemical reaction and almost all of the overcharge energy results in heat generation. If the design of the system and its environment are such that the heat produced can be dissipated and thermal equilibrium can be reached, then the potential for thermal runaway is diminished. However, if the recombination reaction rises to the point where the rate of heat generation exceeds the rate of heat dissipation, the battery temperature will rise and more current will be required to maintain the float voltage. The additional current results in still more recombination and heat generation, which further raises battery temperature. This process is known as thermal runaway, and if left unchecked can result in catastrophic battery failure. This potential problem is further aggravated by elevated ambient temperature, shorted cells, or charging system malfunctions.

Conditions that can lead to thermal runaway include the following:
– High operating ambient without compensation of float voltage
– Improper float voltage adjustment
– Inadequate current limitation in battery charging circuit
– Shorted cell(s) within a battery string
– High ac ripple in dc circuit
– Charger malfunction
– Malfunctions of HVAC systems

An uncorrected thermal runaway condition results in excessive hydrogen evolution, venting, eventual dryout, and failure. When charging current is at maximum levels, the battery temperature can cause meltdown, leading to a fire or explosion.

Ideally, VRLA cells should be placed in a controlled environment. Proper ventilation around the cell casing is recommended to reduce the possibility of thermal runaway. The risk of thermal runaway can be further reduced by limiting the charging current and by temperature compensation of the charging voltage. Some types of cell construction are better suited for the dissipation of heat than others. Contact the manufacturer for additional information.

6.2.2 AC ripple current

AC ripple currents can cause overheating in VRLA batteries and may also have detrimental effects on VLA and, to a lesser extent, Ni-Cd batteries. UPS applications can place unusual conditions on a battery. Typically, UPS battery design seeks excellent short-term, high-rate current characteristics, which, in turn require the lowest possible internal cell resistance. This low resistance allows a lower impedance path for the ripple current coming out of the rectifier stage of the UPS, than the filter capacitors in the output of the rectifier.

In addition, the inverter stage of the UPS requires large transient currents as it builds ac power from the parallel rectifier/battery combination.

With a (high-impedance) ac power source, short-term, instantaneous load current changes will be drawn from the lower impedance battery. These factors may result in a relatively high ac component in the battery. At present, manufacturers place no warranty penalties on VLA cells operating in a high ripple current environment, but some manufacturers do publish maximum allowable ripple for VRLA. Ripple is an important consideration in affecting design life and it is advisable to maintain the rectifier filters as prescribed by the manufacturer.

9.3.2.3 Ripple voltage and current

Many UPS designs use power-switching electronics. The switching of the current causes current harmonics and associated voltage ripple. Periodic measurements of voltage ripple should be taken. High levels of ripple current will cause excessive heating in VRLA cells, elevated water consumption in VLA cells, and accelerated aging in both. Ni-Cd cells will experience elevated water consumption. A common recommendation by the battery manufacturers for maximum ripple voltage, as a percentage of the applied battery float voltage, is 5% peak-to-peak (3.5% of the rms voltage). The maximum ripple current is often expressed as 5% of the eight-hour rated capacity.

9.3.2.7 Temperature

The impact of operating temperature is discussed in 5.3.1. Temperature measurements permit assessment of the temperature differential between cells/units within the battery and the differentials between ambient and electrolyte temperatures. Because of their greater sensitivity to elevated temperature, the measurement frequency for VRLA batteries should be greater than for VLA types. VRLA temperatures should be measured at the negative terminal post of each cell/unit, while VLA temperatures can be measured directly from the electrolyte of a sampling of cells (typically 10%). Corrective action should be taken if the temperature differential between cells/units is greater than 3 ºC. Battery temperatures that are consistently above ambient may indicate high ripple (see 9.3.2.3), overcharging, or internal cell shorting and should be investigated.

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Annex E
E.1.1.5 Ripple currents

UPS applications can place unusual load conditions on a battery such as ripple currents. Ripple current is an important consideration affecting battery life and it is advisable to maintain the UPS as prescribed by the manufacturer.

Annex G

Table G.1—VLA maintenance

VLA battery	Monthly	Quarterly	Annually
Visual inspection of battery	X	X	X
Environmental inspection	X	X	X
Ambient temperature	X	X	X
Detailed inspection of battery		X	X
String float voltage	X	X	X
String float current	X	X	X
Pilot cell float voltage	X	X	X
Pilot cell electrolyte temperature	X	X	X
Individual cell float voltage		X	X
Cell electrolyte temperature (10%)			X
AC ripple current and voltage		X	X
Specific gravity			X
Intercell connection resistance			X
Internal ohmic measurement [a]			X
System load testing [b]			X

[a] For very large VLA cells, some ohmic test sets may lack sufficient resolution for trending purposes. Consult the battery and equipment manufacturer for suitability.

Table G.2—VRLA maintenance

VRLA Battery	Monthly	Quarterly	Annually
Visual inspection of battery	X	X	X
Environmental inspection	X	X	X
Ambient temperature	X	X	X
String float voltage	X	X	X
String float current	X	X	X
Pilot cell/unit float voltage	X	X	X
Individual cell/unit float voltage		X	X
Individual cell/unit temperature		X	X
Intercell connection resistance			X
Internal ohmic measurement		X	X
AC ripple current and voltage	X	X	X
System load testing			X

Table G.3—Ni-Cd maintenance

Ni-Cd	Quarterly	Semiannually	Annually
Visual inspection of battery	X	X	X
Environmental inspection	X	X	X
Ambient temperature	X	X	X
Detailed inspection of battery		X	X
String float voltage	X	X	X
String float current	X	X	X
Pilot cell float voltage	X	X	X
Pilot cell electrolyte temperature	X	X	X
Individual cell float voltage		X	X
Cell electrolyte temperature (10%)			X
AC ripple current and voltage		X	X
Connection torque			X
System load testing			X