VRLA Battery Symptoms and Solutions

1. The following inspections, symptoms and solutions are provided for reference. The actual judgments should be performed by Quality Assurance Department.
2. For assurance of the optimum reliability it is necessary to perform the recommended periodic maintenance. The recommended inspections should be performed at least on a quarterly basis.
3. The recommended periodic inspections can be performed either manually or via automated monitoring systems.
4. The recommended periodic inspections are designed to determine the gradual degradation of the system's capacity and to detect any abnormal system or individual battery condition which could impact system reliability.

VRLA Battery Visual Inspection			
Symptom	Possible Causes	Possible Results	Corrective Actions
Cover/container cracked	Handling or impact damage	Cell dry out or ground fault. Potential internal gas ignition	Replace damaged unit
Cover/container explosion	Ignition of cell's internal gases due to external source, fusing of internal conductive path, or internal spark due to shorting. This potential exists for batteries left in service beyond their useful service life.	Personal injury and equipment damage at time of explosion. Failure to support load.	Replace damaged unit and evaluate any additional batteries
Signs of overheating on battery container	Crack in container causes leaking of electrolyte to grounded rack, etc. Ground fault	Could result in personnel hazard due to conductive path to rack, etc. Could result in smoke or a battery fire Could result in a thermal runaway	Clear the grounded fault and replace defective unit. Evaluate balance of string
Permanently deformed (swollen) container	Thermal runaway possible caused by a high temperature environment, overcharging, excessively high recharge current, shorted cells, ground fault or a combination of these causes	Could result in the emission of hydrogen sulfide which is detectable as a rotten egg odor, battery fire and the inability to support the load	Replace the battery system and correct the items leading to the thermal runaway condition
Rotten egg odor	Possibly caused by a high temperature environment, overcharging or an excessively high recharge current, shorted cells of a combination of these causes	Odor is a product of extended thermal runaway	Replace the battery system and correct the items leading to the thermal runaway condition
Melted grease at terminal	Connections were hot due to excessive resistance caused by a loose connection, dirty contact surfaces or corrosion within the connection	Excessive voltage drop perhaps leading to short operating time or damaged terminals. In extreme case, could lead to melted terminal and ignition of the battery cover	Clean and reassemble the connection if undamaged. Replace any battery with damaged terminals
Corrosion at terminals	These is possibly either residual electrolyte from manufacturing or electrolyte leaking from the battery terminal seal that is attacking the inner-unit connector	Increased connection resistance in the connection, lead to increased heating and voltage drop at high rate discharge	Disassemble connection, clean, coat connecting surfaces and terminal area and seal with oxidation grease and appropriately reassemble the connection. If leakage about the terminal area is obvious, the battery should be replaced.

VRLA Battery Capacity Test Results			
Symptom	Possible Causes	Possible Results	Corrective Actions
Reduced run time at 77°F with smooth voltage decline	Normal wear out	Eventual failure to support the load followed by potential for shorted cells.	Replace battery system when at 80% of rated capacity or before
Reduced run time at 77°F with steep voltage decline or voltage plateaus	Individual low capacity cells	Reversed cells during discharge. Reversed cells will become very hot and will not recharge	Replace the isolated low capacity batteries
Excessive initial voltage drop even to the point of dropping load in the first several Seconds	Battery is cold		Warm up the battery
	Cabling is too small	Excessive voltage drop	Add parallel cables
	High resistance connections	Excessive voltage drop	Clean and reassemble connections
	Battery is undersized		Add required parallel strings
	Shorted cells	Cells will become hot, could develop thermal runaway, internal arcing could result in explosion	Replace isolated units with shorts and evaluate entire string

VRLA Battery DC Voltage Inspections			
Symptom	Possible Causes	Possible Results	Corrective Actions
System float voltage greater than 2.3 V/cell at an average temperature of 77°F (25°C)	Charger output voltage set incorrectly	Overcharging will cause excessive gassing and drying of the electrolyte, potential of thermal runaway	Reset the charge output voltage to the recommended value
System float voltage less than an average of 2.25 V/cell	Charger output voltage set incorrectly	Undercharging will result in gradual loss of operation time and capacity with successive discharge cycles. If allowed to persist, an irreversible level of lead sulfate will develop on the plates with the result of a permanent loss of capacity.	Reset the charger output voltage to the recommended value. Equalize the battery system for 48 to 72 hours and perform a capacity test. If loss is permanent, replace the total battery system
System equalize voltage is greater than an average of 2.45 V/cell	Charger equalization voltage is set incorrectly	Overcharging will cause excessive gassing and drying of the electrolyte and will contribute to potential thermal runaway	Reset the charger output voltage to the recommended value
System equalize voltage is less than an average of 2.45 V/cell	Charger equalization voltage is set incorrectly	Equalization and boost charging will be less effective and will require extended time	If possible, reset the charger output voltage to the recommended value or accept a longer equalization time
Individual battery float voltage less than an average of 2.2 V/cell (13.3 VDC for 6 cell battery, 11.1 VDC for 5 cell battery, 6.6 VDC for 3 cell battery)	Potentially the individual battery has a shorted cell. This could be verified with an impedance or conductance check	Reduced operating time under a load, increased float current, heating during discharge, contributes to potential thermal runaway	Replace the individual battery
Individual battery float voltage greater than an average of 2.42 V/cell (14.5 VDC for 6 cell battery, 12.1 for 5 cell battery, 7.3 for 3 cell battery)	Potentially there may be an open cell in the individual battery. This can be confirmed by checking for zero float current or checking for a very high impedance of the battery.	Failure to support the load. Could result in an internal arc which could ignite the gasses within the cell	Replace the individual battery
DC voltage measured between either of the battery system output terminals and ground (rack) or a ground fault indicated by automatic monitoring equipment	Damaged battery container allowing electrolyte to leak out to the grounded surface (rack)	Personnel shock hazard which could result in serious injury or electrocution Potential burning of the container at damaged area or battery fire	Determine the source of the ground fault and replace the battery

VRLA Battery Float Charging Current Inspections			
Symptom	Possible Causes	Possible Results	Corrective Actions
Float current to the string is zero	A battery or connection in the series string is open. This can be verified via the float voltage or impedance check of the individual batteries.	Failure to support the load. If an internal arc should occur during discharge, it could ignite the internal gasses of the cell.	Replace the battery with the open cell or repair the open/loose external connection.
		If there is an open/loose connection in the external conductive path, it could damage the termination under load.	
Float current current exceeds 0.03CA at 77°F (25°C) at float charge.	Batteries are not yet fully recharged	Not at 100% of capability	Determine the specific cause and take the necessary corrective action
	Batteries are above 77°F (25°F)	Leads to thermal runaway	
	Potentially shorted cells in battery	Leads to thermal runaway	
	Depending on the degree, the battery may be entering or in thermal runaway	Thermal runaway results in eventual meltdown of the battery and the potential of hydrogen sulfide emissions and fire	
AC ripple current exceeds 5 amperes per 100 Ah rated battery capacity	Poor filtering of the charger	Excessive AC ripple current will result in battery heating	Improve the charger output filtering

VRLA Battery Temperature Inspections			
Symptom	Possible Causes	Possible Results	Corrective Actions
Elevated room temperature	Lack of adequate air conditioning/ventilation	Reduced battery life	Cool the room or accept reduced battery life
Elevated battery temperature	Elevated room temperature	Reduced life and potential thermal runaway	Improve room air conditioning
	Inadequate cabinet ventilation	Reduced life and potential thermal runaway	Improved cabinet ventilation and temperature
	Discharge-Charge cycle	Can be normal if not exceeding 18°F (10°C) increase	Limit recharge current
	AC ripple current greater than 5 amperes rms/100 Ah battery capacity	Reduced life and potential thermal runaway	Determine the cause of the excessive AC ripple current and correct
High current recharge	High charging voltage	The combination can lead to thermal runaway	Limit recharge current
	Shorted cells		Reduce to within specifications
			Reduce shorted cells and evaluate total string

VRLA Battery High Rate 10 Second Load Test			
Symptom	Possible Causes	Possible Results	Corrective Actions
Terminal voltage is marginally below the minimum voltage specified for 10 Second point	Battery could not be fully charged or is an older battery that has been in service and has a somewhat lower capacity	Could have a reduced operating time	Fully recharge the filtering
Terminal voltage is significantly below the minimum voltage specified for 10 Second point	Battery is discharged or there is deterioration of the conductive path, plate grid, active material or electrolyte volume	Reduced operating time	Charge and reset battery or replace as required
	Shorted	Conductive to thermal runaway	
	Open cells	Will not support load	

VRLA Battery Connection Hardware Resistance / Tightness Inspection			
Symptom	Possible Causes	Possible Results	Corrective Actions
Connection resistance increase of 20% or more from original value	Repetitive cycles resulting in heating and cooling of connection can result in relaxation of torque and an increase in connection resistance	Loose connections can result in heat damaged or melted terminals during high rate discharge	Re-torque the connection as required
	Contamination within the connection can result in corrosion and high terminal resistance	Excessive voltage drop during high rate discharge resulting in reduced operating time	
Connection hardware tightness is less that the specified re-torque value	Repetitive cycles resulting in heating and cooling of connection can result in relaxation of torque and an increase in connection resistance	Loose connections can result in heat damaged or melted terminals during high rate discharge	Re-torque the connection as required
When new impedance/resistance increases by 50% from original value or conductance declines to 50%	Battery is discharged or there is deterioration of the conductive path, plate grid, active material or electrolyte volume	Reduced operating time	Charge and reset battery or replace as required
	Shorted cells	Conductive to thermal runaway	
	Open cells	Will not support load	

VRLA Battery AC Ripple Voltage Inspections			
Symptom	Possible Causes	Possible Results	Corrective Actions
AC ripple (p-p) voltage on the system is greater than 4% of the value of the DC float voltage	Poor filtering of the charger output	Excessive AC ripple could cause the battery to cycle at the ripple frequency and result in heating and deterioration of the active plate material	Improve the charger output filtering
Individual battery in string exhibits AC ripple voltage of twice that of the other typical batteries in the string	Battery with the high AC ripple voltage has a proportionately higher impedance and should be further evaluated for performance. Subject battery could have a deteriorating conductive path or a dry, shorted or open cell	Reduce operating time Potential conditions could be conductive to thermal runaway	Verify the battery condition and replace as required