# Vertiv™ Liebert® Energy Storage Systems
# GUIDE SPECIFICATIONS

## 1.0 VALVE-REGULATED LEAD ACID BATTERY POWER PACK

The UPS system shall be provided with a valve-regulated lead acid battery plant.

The battery shall be fully charged per the manufacturer's instructions during startup and shall demonstrate the specified operating time.

### 1.1 Matching Battery Power Pack

The battery power pack shall consist of sealed, valve-regulated batteries, a circuit breaker for isolating the battery pack from the UPS and a control interface to the UPS module.

The circuit breaker shall be sized to allow discharge at the maximum published rating of the battery. The interface to the UPS module shall provide status and thermal data to allow the UPS to regulate the charging voltage and inhibit the conditions associated with battery thermal runaway. If the temperature measurement in a battery cabinet indicates that thermal runaway is occurring, then the UPS controls shall isolate the cabinet from the charger by tripping the battery breaker in that cabinet while leaving the other battery cabinets connected to allow UPS operation during a loss of power to the rectifier.

The battery cabinet shall be rated NEMA 1, matching the UPS style and design.

- **Battery Cabinets Connected Directly to the UPS**: The manufacturer shall provide all power and control parts necessary to connect the UPS to the battery cabinets.
- **Battery Cabinets Separated from the UPS**: The manufacturer shall provide all power and control parts necessary to interconnect the battery cabinets. The installer shall provide all cabling necessary to interconnect the UPS and the battery cabinets.

Both overhead and under-floor site installed cabling shall be accommodated. Cable installation shall not require removal of batteries or any other battery cabinet assemblies.

The battery system shall be sized to support a _____kW load for _____ minutes. The battery system shall provide 100% initial capacity upon delivery.

The battery shall be lead-calcium, sealed, valve-regulated type with a three (3) -year full warranty and a seven (7) -year pro rata warranty under full float operation. The battery design shall utilize absorbent glass mat (AGM) technology to immobilize the electrolyte.

#### 1.1.1 Optional Battery System Monitor

The battery system shall be provided with an Vertiv™ Liebert® Alber™ universal battery diagnostic system. The system shall provide predictive on-line test, analysis and remote monitoring.

The system shall include automatic monitoring, alarming, recording and displaying of these battery parameters.

- Individual jar voltage (high and low alarm)

- Individual jar DC resistance (high and low alarm) accomplished by applying a momentary load at user-defined intervals
- Individuals inter tier and disconnect switch resistance measurements (high alarm) performed at user-defined intervals
- Total overall battery voltage per string (high and low alarm)
- Two ambient temperatures per string for temperature trending (high and low alarm)
- Real time system discharge logging of the overall voltage, individual jar voltage (low alarm), discharge current (high alarm) and temperatures
- Ripple current per string
- String current (high alarm)
- Optional float current per string (high and low alarm)

The system shall provide reports for evaluation of the battery condition. Reports shall include:

- Alarm condition reporting – tabular, fax or e-mail
- Jar out-of-limits summary report – tabular
- Individual jar voltages over time – graph or tabular
- Individual jar resistance values over time – graph or tabular
- Total battery voltage over time – graph or tabular
- Ambient temperature over time – graph or tabular
- Discharge report: total battery voltage decay vs. time – graph or tabular
- Discharge report: jar voltage decay vs. time – graph or tabular
- Discharge hit summary report – tabular
- Discharge hit interval summary report – tabular
- General summary report of battery and monitor status of all systems to the battery or string level based on user-set thresholds
- Detail summary reports of battery and monitor status of all systems with a line graph trend of any parameter that violated a threshold
- Executive report showing overall system health.

Data from universal battery diagnostic system shall be viewed through an Ethernet port with one of the following protocols: SNMP, TCP/IP/Modbus, SMS or HTTP. An optional RS-485 port shall be available for Modbus communication.

# 2.0 FLOODED-CELL BATTERY SYSTEM

The UPS system shall be provided with a vented, lead acid battery plant.

The battery shall be fully charged per the manufacturer's instructions during startup and shall demonstrate the specified operating time.

## 2.1 Flooded-Cell Battery System on Rack

The battery shall be a lead-calcium stationary battery with a 20-year pro rata warranty under full float operation.

### 1. Ratings

- **Backup Time**: ____ minutes.
- **Load kW**: ____ kW.
- **Maximum Specific Gravity**: ____.
- Racks shall be ____-tier, certified for seismic zone ____.

### 2. Alloys

Grids shall be manufactured of lead-calcium alloys to ensure long life and consistently low gassing rate over the entire service life; all internal wetted parts shall be of similar non-antimonial alloy to preclude interfacial corrosion at the bonded area.

### 3. Plates

Both positive and negative plates shall be of the flat pasted plate design to ensure highly reliable electrical performance throughout the life of the battery. Positive plates shall be at least 0.16 in. (4mm) thick. Physical support of the positive plate group shall be via a suspension system that allows for normal plate expansion without stressing the jar or cover. The plates shall be of the "wrapped plate design," such as C&D XT Plus or EnerSys DXC, for high cycle application.

### 4. Terminals

All batteries larger than 1.5kW/cell (15-minute rate to 1.67 volts per cell) shall include copper inserted terminal posts allowing connector torque of 160 pound-inches and copper-to-copper interface with the intercell connector (except for flashing). Terminal posts shall be of sufficient strength to support normal inter-tier or inter-step cabling without additional bracing.

### 5. Container

The cell cover shall be of a flame-retardant material with an oxygen index of at least 28; all jars must be transparent to allow visual inspection of the plates and sediment spaces. Cell covers shall include provision for sampling of the electrolyte below the tops of the plates.

### 6. Intercell Connections

For each bolted connection, lead-plated copper connectors and corrosion-resistant bolts shall be provided; interconnecting hardware shall be sized to permit discharge at the maximum published rate while allowing no more than 30 mV of voltage drop between adjacent units at the one-minute rate to 1.75 volts per cell (VPC). Along with the necessary hardware, the supplier shall furnish NO-OX-ID grease to coat the contact area of all electrical connections.

**7. Racks**

Racks shall have welded steel support frames and unitized rail construction to prevent long-term warping and resulting stresses on the cells and interconnections. All metallic rack components that directly contact the battery shall be insulated by removable covers.

**8. Packaging**

Packaging must allow lifting straps to be inserted beneath the cells without moving, lifting or tilting the cells. Packaging shall ensure that plates are oriented perpendicular to the normal direction of travel during transportation.

**9. Manufacturing Controls**

Each cell shall be clearly identified as to cell type, voltage and capacity, as well as manufacturing control group, for future quality assurance traceability. All cells in the battery shall be tested to ensure 100% system capacity. The equipment shall be designed and manufactured under a quality assurance program that is controlled and documented by written policies, procedures or instructions, and that shall be carried out throughout the performance of the work. The quality assurance program shall conform to the requirements of ANSI N45.2, MIL I-45208A and MIL-Q-9858.

### 2.1.1 Battery Disconnect Breaker for Battery System on Racks

Each battery string shall be supplied with a molded-case circuit breaker listed to UL 489, supplement SC, for applications greater than 250VDC. The trip rating of the breaker shall be sized to allow the battery to operate at full rated capacity at the five-minute discharge rate. This shall allow a partially loaded UPS to operate even if one or more battery strings are offline. The molded-case circuit breaker interrupting rating shall be greater than the battery string fault current capability. The molded-case circuit breaker trip unit shall have an instantaneous trip of 135% of the breaker trip rating to ensure that a partially charged battery has sufficient fault current to trip the breaker. For other trip values greater than 135%, UPS manufacturer shall provide, upon request, calculations demonstrating proper coordination between battery and breaker.

The battery breaker shall be in a separate NEMA 1 enclosure for all systems on racks. When the breaker is open, there shall be no battery voltage in the UPS enclosure. The UPS shall automatically be disconnected from the battery by opening the breaker when the battery reaches the minimum discharge voltage level or when signaled by other control functions. The UPS shall be provided with a push button to trip the breaker from the control panel.

### 2.1.2 Optional Battery System Monitor

The battery system shall be provided with an Vertiv™ Liebert® Alber™ universal battery diagnostic system. The system shall provide predictive on-line test, analysis and remote monitoring.

The system shall include automatic monitoring, alarming, recording and displaying of these battery parameters.

- Individual cell voltage (high and low alarm)
- Individual cell DC resistance (high and low alarm) accomplished by applying a momentary load at user-defined intervals.
- Individual inter-tier and disconnect switch resistance measurements (high alarm) performed at user-defined intervals.

- Optional individual intercell resistance measurements performed at user defined intervals.
- Total overall battery voltage per string (high and low alarm).
- Ambient temperatures per string for temperature trending (high and low alarm), with ability to add up to 10 temperatures per string for temperature trending (optional).
- Real time system discharge logging of the overall voltage, individual cell voltage (low alarm), discharge current (high alarm), and temperatures.
- String current (high alarm).
- Optional float current per string (high and low alarm)

The system shall provide reports for evaluation of the battery condition. Reports shall include:

- Alarm condition reporting – tabular, fax or e-mail
- Cell out-of-limits summary report – tabular
- Individual cell voltages over time – graph or tabular
- Individual cell resistance values over time – graph or tabular
- Total battery voltage over time – graph or tabular
- Ambient temperature over time – graph or tabular
- Discharge report: total battery voltage decay vs. time – graph or tabular
- Discharge report: cell voltage decay vs. time – graph or tabular
- Discharge hit summary report – tabular
- Discharge hit interval summary report – tabular
- General summary report of battery and monitor status of all systems to the battery or string level based on user-set thresholds
- Detail summary reports of battery and monitor status of all systems with a line graph trend of any parameter that violated a threshold
- Executive report showing overall system health.

Data from universal battery diagnostic system shall be viewed through an Ethernet port with one of the following protocols: SNMP, TCP/IP/Modbus, SMS or HTTP. An optional RS-485 port shall be available for Modbus communication.

# 3.0 VERTIV™ ENERGYCORE™ LITHIUM 5 BATTERY SYSTEM

The UPS system shall be provided with the Vertiv™ EnergyCore™ Lithium 5 version of the lithium-ion battery system. This version of the Vertiv™ EnergyCore™ Lithium 5 battery system has successfully completed a UL 9540A fire test.

**Critical Fire Safety Compliance Note to Customers and Engineers**

This product was tested by CSA Group Testing and Certification Inc. regarding UL 9540A: Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems, as described in the "UL 9540A Checklist and Test Result (4th Edition) Unit Level – 80132596 Updated" test report. Vertiv can make this test report available upon request for the purpose of assisting Vertiv's customers, their engineers, and other stakeholders in satisfying their obligations to comply with all applicable fire safety, building, and electrical regulations, as well as any other laws or guidelines governing installation or use of this product.

The battery shall be fully charged per the manufacturer's instructions during startup and shall demonstrate the specified operating time.

## 3.1 Battery System

The battery system shall consist of lithium-ion batteries and the control interface to the UPS module. A single interface between the lithium-ion battery racks and the UPS module shall provide status and control of the battery cabinet's internal contactor.

The battery rack shall be rated NEMA 1, which matches with the UPS look and feel.

Overhead-installed cabling shall be accommodated. The battery rack shall be provided with an optional conduit box or extension box and shall provide terminals suitable for two-hole, long-barrel compression lugs internal to the cabinet. Cable installation shall not require removal of batteries or any other battery rack assemblies.

The installer shall provide all cabling necessary to interconnect the UPS and the battery cabinets.

The battery rack shall be equipped with an HMI on front door to display battery status, warning/alarm information, only (1) HMI per system is sufficient.

The battery rack shall be equipped with press buttons and LED lights for indication and operation.

Control power for the lithium battery management system shall derive power directly from the lithium batteries.

External control power shall not be accepted.

The battery rack shall be shipped with lithium batteries preassembled in the rack. Field assembly of batteries shall not be accepted.

### 3.1.1 Battery Module

The battery system shall be sized to support a _____kW load for _____ minutes. The battery system shall provide 100% initial capacity upon delivery.

The battery system shall be operating between 20°C to 30°C ambient temperature.

The battery module shall be Ampace brand 60Ah 9S3P (lithium iron phosphate) with a ten (10) - year warranty for battery performance.

### 3.1.2 BMS (Battery Management System) Design

The battery system shall be provided with an integrated battery management system. The system shall provide battery safety and on-line remote monitoring.

- The BMS shall protect the batteries in case of over current, over voltage, over temperature, under voltage, under temperature, low battery, charge over current, etc.
- The BMS shall provide warning and fault alarms locally and remotely for the events listed above.
- The BMS shall be powered by DC voltage
- The BMS shall be equipped with redundant power supply
- The BMS shall provide state of charge and runtime calculation
- The BMS shall provide cell voltage balancing function
- The BMS shall provide discrete signals for battery system/rack status, warnings and alarms
- The BMS shall have voltage balance function for battery racks on the same UPS
- The BMS shall have synchronized EOD (End-of-Discharge) function
- The BMS shall store battery operating data

The BMS system shall include system, rack and battery module monitoring of these battery parameters:

- Individual cell voltage
- Cell temperature
- Cell balance per battery module
- Rack voltage
- Rack current
- Rack power
- Rack average cell temperature
- Rack target state of charge
- Rack state of charge
- Rack status, warnings and fault alarms

- System target state of charge
- System average state of charge
- System runtime remaining
- System status, warning and fault alarms (also reported to the UPS)

Data from the battery system monitor shall be viewed through an Ethernet port with Modbus/TCP/IP.

# 4.0 VERTIV™ ENERGYCORE™ LITHIUM 7 BATTERY SYSTEM

The UPS system shall be provided with the Vertiv™ EnergyCore™ Lithium 7 version of the lithium-ion battery system. This version of the Vertiv™ EnergyCore™ Lithium 7 battery system has successfully completed a UL 9540A fire test.

**Critical Fire Safety Compliance Note to Customers and Engineers**

This product was tested by CSA Group Testing and Certification Inc. regarding UL 9540A: Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems, as described in the "UL 9540A Checklist and Test Result (4th Edition) Unit Level – 80217568 test report. Vertiv can make this test report available upon request for the purpose of assisting Vertiv's customers, their engineers, and other stakeholders in satisfying their obligations to comply with all applicable fire safety, building, and electrical regulations, as well as any other laws or guidelines governing installation or use of this product.

The battery shall be fully charged per the manufacturer's instructions during startup and shall demonstrate the specified operating time.

## 4.1 Battery System

The battery system shall consist of lithium-ion batteries and the control interface to the UPS module. A single interface between the lithium-ion battery racks and the UPS module shall provide status and control of the battery cabinet's internal contactor.

The battery rack shall be rated NEMA 1, which matches with the UPS look and feel.

Overhead-installed cabling shall be accommodated. The battery rack shall be provided with an optional conduit box or extension box and shall provide terminals suitable for two-hole, long-barrel compression lugs internal to the cabinet. Cable installation shall not require removal of batteries or any other battery rack assemblies.

The installer shall provide all cabling necessary to interconnect the UPS and the battery cabinets.

The battery rack shall be equipped with an HMI on front door to display battery status, warning/alarm information, only (1) HMI per system is sufficient.

The battery rack shall be equipped with press buttons and LED lights for indication and operation.

Control power for the lithium battery management system shall derive power directly from the lithium batteries.

External control power shall not be accepted.

The battery rack shall be shipped with lithium batteries preassembled in the rack. Field assembly of batteries shall not be accepted.

### 4.1.1 Battery Module

The battery system shall be sized to support a _____kW load for _____ minutes. The battery system shall provide 100% initial capacity upon delivery.

The battery system shall be operating between 18°C to 28°C ambient temperature.

The battery module shall be Samsung brand 67Ah 8S1P (lithium magnesium oxide/lithium nickel manganese cobalt oxide) with a ten (10) -year warranty for battery performance.

### 4.1.2 BMS (Battery Management System) Design

The battery system shall be provided with an integrated battery management system. The system shall provide battery safety and on-line remote monitoring.

- The BMS shall protect the batteries in case of over current, over voltage, over temperature, under voltage, under temperature, low battery, charge over current, etc.
- The BMS shall provide warning and fault alarms locally and remotely for the events listed above.
- The BMS shall be powered by DC voltage
- The BMS shall be equipped with redundant power supply
- The BMS shall provide state of charge and runtime calculation
- The BMS shall provide cell voltage balancing function
- The BMS shall provide discrete signals for battery system/rack status, warnings and alarms
- The BMS shall have voltage balance function for battery racks on the same UPS
- The BMS shall have synchronized EOD (End-of-Discharge) function
- The BMS shall store battery operating data

The BMS system shall include system, rack and battery module monitoring of these battery parameters:

- Individual cell voltage
- Cell temperature
- Cell balance per battery module
- Rack voltage
- Rack current
- Rack power
- Rack average cell temperature
- Rack target state of charge
- Rack state of charge
- Rack status, warnings and fault alarms
- System target state of charge
- System average state of charge
- System runtime remaining
- System status, warning and fault alarms (also reported to the UPS)

Data from the battery system monitor shall be viewed through an Ethernet port with Modbus/TCP/IP.

# 5.0 SAMSUNG LITHIUM-ION BATTERY SYSTEM

The UPS system shall be provided with the Samsung SDI UL 9540A version of lithium-ion battery cabinets. This version of the Samsung lithium-ion battery systems has successfully completed a UL 9540A fire test.

The battery shall be fully charged per the manufacturer's instructions during startup and shall demonstrate the specified operating time.

## 5.1 Battery System

The battery system shall consist of lithium-ion batteries, circuit breaker for isolating the battery rack from the UPS and control interface to the UPS module. The circuit breaker shall be sized to allow discharge at the maximum published rating of the battery. A single interface between the lithium-ion battery racks and the UPS module shall provide status and control of the battery cabinet's internal breaker.

The battery rack shall be rated NEMA 1 with front door, side covers and rear cover and shall be suitable for installation in a limited-access area.

Overhead-installed cabling shall be accommodated. The battery rack shall be provided with an optional conduit box and shall provide terminals suitable for two-hole, long-barrel compression lugs. Cable installation shall not require removal of batteries or any other battery rack assemblies.

The installer shall provide all cabling necessary to interconnect the UPS and the battery cabinets.

The battery system shall be sized to support a _____kW load for _____ minutes. The battery system shall provide 100% initial capacity upon delivery.

The battery shall be Samsung 67Ah 8S1P (lithium magnesium oxide/lithium nickel manganese cobalt oxide) with a ten (10) - year warranty for battery capacity under full float operation and a three (3) - year warranty to be free from defects in design, materials & workmanship.

### 5.1.1 Battery System Monitor

The battery system shall be provided with an integrated battery monitoring system. The system shall provide battery safety and on-line remote monitoring.

The system shall include system, rack and battery module monitoring of these battery parameters:

- Individual cell voltage
- Individual cell temperature
- Cell balance per battery module
- Rack voltage
- Rack average cell voltage
- Rack current
- Rack average cell temperature
- Rack state of health
- Rack state of charge
- Rack major and minor alarms
- Rack disconnect position

- System average state of charge
- System major and minor alarms (also reported to the UPS)

Data from the battery system monitor shall be viewed through an Ethernet port with TCP/IP/Modbus.

# 6.0 ZINCFIVE NICKEL-ZINC BATTERY SYSTEM

The UPS system shall be provided with the ZincFive version of Nickel-Zinc battery cabinets. This version of the ZincFive Nickel-Zinc battery systems has successfully completed a UL 9540A fire test at the cell level and did not exhibit thermal runaway.

The battery shall be fully charged per the manufacturer's instructions during startup and shall demonstrate the specified operating time.

## 6.1 Battery System

The battery system shall consist of Nickel-Zinc batteries, circuit breaker for isolating the battery rack from the UPS and control interface to the UPS module. The circuit breaker shall be sized to allow discharge at the maximum published rating of the battery. A single interface between the Nickel-Zinc battery racks and the UPS module shall provide status and control of the battery cabinet's internal breaker.

The battery cabinet shall be rated NEMA 1 with front door, side covers and rear cover and shall be suitable for installation in a limited-access area.

Overhead-installed cabling shall be accommodated. The battery rack shall provide terminals suitable for two-hole, long-barrel compression lugs. Cable installation shall not require removal of batteries or any other battery rack assemblies.

The installer shall provide all cabling necessary to interconnect the UPS and the battery cabinets.

The battery system shall be sized to support a _____kW load for _____ minutes. The battery system shall provide 100% initial capacity upon delivery.

The battery shall be ZincFive 80Ah (38 Module) (Nickel-Zinc) with a ten (10) - year warranty for battery runtime under full float operation and a three (3) - year warranty to be free from defects in design, materials & workmanship.

### 6.1.1 Battery System Monitor

The battery system shall be provided with an ZincFive BX50-U battery monitoring system capable of supporting up to fifty (50) ZincFive Nickel-Zinc batteries. The system shall provide battery safety and on-line remote monitoring.

The system shall include system, rack and battery module monitoring of these battery parameters:

- Module voltage
- Module temperature
- Rack voltage
- Rack current
- Rack state of health
- Rack state of charge

- Rack major and minor alarms
- Rack disconnect position
- Data from the battery system monitor shall be viewed through an Ethernet port with TCP/IP/Modbus.

# 7.0 VYCON FLYWHEEL ENERGY STORAGE SYSTEM

The UPS system shall be provided with a Vycon energy storage system.

## 7.1 Energy Storage System

The energy storage system shall consist of the number of Vycon flywheel units necessary to provide the specified operating time. Each flywheel unit shall be provided with an internal circuit breaker for isolating the flywheel unit from the UPS and a control interface to the UPS module. Interfaces between the flywheel unit and the UPS module shall provide status and control of the flywheel unit internal breaker.

The flywheel unit shall be housed in a freestanding cabinet with a NEMA 1 construction rating or IEC equivalent. No space shall be required between the back or sides of the cabinet and any walls. The flywheel unit shall accommodate top access for onsite wiring.

The installer shall provide all cabling necessary to interconnect the UPS and the flywheel units.

The energy storage system shall be sized to support a _____kW load for _____ seconds.

The energy storage system shall be designed for 20 years of UPS application.

### 7.1.1 Energy Storage System Monitor

The energy storage system shall be provided with an integrated monitoring system and LCD (optional touchscreen) status display. The system shall provide status and on-line remote monitoring through an optional communication interface.

The system shall include monitoring of these energy storage status items:

- Ready to Start
- Starting-up
- Charging
- Ready (Full Charge)
- Discharging
- System Parameters Elevated
- Flywheel Shutdown
- Emergency Power Off

The system shall display the following parameters:

- DC Bus Voltage, VDC
- DC Bus Current, Amps
- DC Bus Power, kW

- Flywheel Speed, % Operating Speed
- Inverter Temperature Status
- Pre-charge Contactor Status
- DC Isolation Contactor Status
- Magnetic Bearing Status
- Vacuum Level Status
- Enclosure Temperature Status
- Flywheel Energy Storage System Hours
- Number of Discharge Events

The following warnings and alarms shall be displayed when the Warning/Alarm Events screen is accessed:

- Vacuum Level
- Enclosure Temperature
- IGBT Temp. Phase A
- IGBT Temp. Phase C
- Precharge Contactor
- DC Bus Isolation Contactor
- Magnetic Bearing Failure
- System Alarm
- Enclosure Temperature Fault
- Vacuum Level Fault
- Remote EPO
- Emergency Power Off
- Pre-charge Timeout
- User Stop Initiated
- High DC Voltage
- Low DC Voltage

The flywheel unit shall have provisions for an optional Modbus interface. The Modbus interface shall use the RS-485 protocol and shall provide information to monitor system performance.