Vertiv™ Liebert® EXM UPS
Single-Module Uninterruptible Power System
30-250kVA, 480V
GUIDE SPECIFICATIONS

1.0 GENERAL

1.1 Summary

These specifications describe requirements for an Uninterruptible Power System (UPS) optimized for maximum efficiency. The UPS shall automatically maintain AC power to the critical load within specified tolerances and without interruption during failure or deterioration of the normal power source.

The manufacturer shall design and furnish all materials and equipment to be fully compatible with electrical, environmental and space conditions at the site. The UPS shall include all equipment to properly interface the AC power source to the intended load and shall be designed for unattended operation.

1.2 Standards

The UPS and all associated equipment and components shall be manufactured in accordance with the following applicable standards:

- The UPS shall be UL listed per UL Standard 1778, Fifth edition, Uninterruptible Power Supplies, and shall be CSA Certified.
- The UPS shall be provided with a Short Circuit Withstand Rating (SCWR) label denoting the maximum source fault short circuit current that is applicable to the unit. The withstand rating shall be independently verified by a nationally recognized, third-party lab.
- The UPS shall withstand input surges to both the rectifier and bypass when configured as either a single-input or as a dual-input unit without damage as per the criteria in EN62040-2 (4kV). The manufacturer shall provide evidence of compliance upon request.
- The UPS shall comply with FCC Rules and Regulations, Part 15, Subclass B, Class A. This compliance is legally required to prevent interference with adjacent equipment. The UPS shall have a label stating FCC compliance. The manufacturer shall provide evidence and test data of compliance upon request.
- The UPS shall be compatible with the wiring practices, materials and coding in accordance with the requirements of the National Electrical Code, OSHA and applicable local codes and standards. Provisions shall be made in the cabinets to permit installation of input, output and external control cabling using raceway or conduit for top and bottom access to input, output, bypass and DC connections. Connection cabinets shall provide for wiring gutter and wire bend radius as defined by the NEC and UL.
- The UPS classification shall be VFI-SS-111 per the criteria in IEC EN62040-3.
- The UPS shall comply with the Energy Star program requirements for Uninterruptible Power Supplies (UPSs) – eligibility criteria, version 2.0.
- The UPS and matching Battery Cabinets shall be seismically certified in accordance with the 2015 International Building Code (IBC), 2016 California Building Code (CBC), and American Society of Civil Engineers (ASCE) Minimum Design Loads, with seismic performance of Sds=1.93, Ip=1.5 and z/h=1.0. Optional seismic brackets shall be available from the UPS manufacturer for use in compliance with this certification.

1.3 System Description

1.3.1 Design Requirements

- The UPS shall be sized to provide a minimum of ____kW output (unity load power factor rating)
- The UPS output capacity shall have the option to enable scalability at the time of ordering and shall be upgradeable by Vertiv Services.
- Models shall be available in two frames:
  - 200kVA frame – Scalable from 50kVA to 200kVA (50kVA hardware increments)
  - 250kVA frame – Scalable from 50kVA to 250kVA (50kVA hardware increments).
- The UPS shall have the option to configure the 30-200kVA system for N+1 internal redundancy at the time of order.
- The UPS shall be able to supply all required power to full rated output kVA loads with power factor from 0.5 lagging to 0.9 leading. The UPS shall also work from unity power factor to 0.5 leading power factors subject to derating.
- Load voltage and bypass line voltage shall be 480VAC, three-phase, three-wire plus ground. Input voltage shall be 480VAC, three-phase, three-wire plus ground. The AC input source and bypass input source shall each be a solidly grounded wye service.
- The VRLA battery shall support the UPS at 100% rated kW load for at least _____ minutes at 77°F (25°C) at startup and _____ minutes at end of life (EOL run time) at 77°F (25°C).
- The Lithium-ion battery shall support the UPS at 100% rated kW load for at least _____ minutes at startup (initial run time) and _____ minutes at end of life (EOL run time) at 77°F (25°C).
- The UPS shall have an active power factor-corrected IGBT converter/rectifier, capable of maintaining input power factor and input current total harmonic distortion (THDi) within specifications without an additional input filter.
- The UPS shall be of transformer-free design, requiring no internal transformer in the main power path for the basic operation of the module. Optional transformers in cabinets or otherwise external to the basic UPS module shall be permissible to provide isolation and/or voltage transformation.

1.3.2 Modes of Operation

The UPS shall operate as an on-line reverse transfer system in the following modes:

1. **Normal:** The critical AC load shall be continuously powered by the UPS inverter. The rectifier/charger shall derive power from the utility AC source and supply DC power to the DC-DC converter, which in turn shall supply the inverter while simultaneously float charging the battery.
2. **ECO Mode:** The critical AC load shall be continuously powered by the bypass with the inverter available to power the load if the bypass source voltage or frequency exceeds adjustable parameters of power quality.
3. **Battery:** Upon failure of utility AC power, the critical load shall be powered by the inverter, which, without any switching, shall obtain its power from the battery plant via the DC-DC converter. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.
4. **Recharge:** Upon restoration of the utility AC source, the rectifier shall supply power to the output inverter and to the DC-DC converter, which shall simultaneously recharge the batteries. This shall be an automatic function and shall cause no interruption to the critical load.

5. **Bypass:** If the UPS must be taken out of service, the static transfer switch shall transfer the load to the bypass source. The transfer process shall cause no interruption in power to the critical load. An optional external wrap-around maintenance bypass shall be used to ensure full isolation of the unit for the service of internal components while providing safety from arc flash and in compliance with OSHA requirements.
6. **Off-Battery:** If the battery only is taken out of service, it shall be disconnected from the DC-DC converter by means of an external disconnect circuit breaker (in the case of external batteries). The UPS shall continue to function and meet all of the specified steady-state performance criteria, except for the power outage backup time capability. If multiple battery strings are used, each string shall be capable of being electrically isolated for safety during maintenance.

1.3.3 Performance Requirements

The solid-state power components, magnetics, electronic devices and overcurrent protection devices shall operate within the manufacturer's recommended temperature when the UPS is operating at 100% critical load and maintain battery charging under either of the following conditions:

1. Any altitude within the specified operating range up to 4922 ft. (1500m) elevation
2. Any ambient temperature within the specified operating range of 32°F to 104°F (0°C to 40°C)

1.4 Input

1. **Voltage:** Input/output voltage specifications of the UPS shall be
    - Rectifier AC Input: 480V, three-phase, three -wire-plus-ground
    - Bypass AC Input: 480V, three-phase, three -wire-plus-ground
    - AC Output: 480V, three-phase, three -wire-plus-ground
2. **Voltage Range:** +20%, -15% at full load; -40% at half load
3. **Frequency Range:** 40 - 70Hz
4. **Maximum Inrush Current:** UPS inrush current not to exceed 1.5 times rated input current
5. **Input Current Walk-In:** The UPS shall contain a controlled module walk-in to minimize inrush current upon auto-restart. The module walk-in is programmable for a 1 to 5 second delay.
6. **Power Factor:** Minimum 0.99 at full load with nominal input voltage
7. **Current Distortion:** Less than or equal to 5% input current THDi at full load input current in double-conversion mode (nominal input voltage, <1% input voltage THDv, and <1% input voltage imbalance)
8. **Surge Protection:** Withstands input surges of 4kV (Line to ground) without damage as per criteria listed in EN 61000-4-5: 1995
9. **Short Circuit Current Rating:** Units shall carry as standard 65kA Short Circuit Withstand Rating. All ratings shall be certified and a label shall be applied to the unit clearly identifying this rating as required by the National Electrical Code.

1.4.1 AC Output

1. **Load Rating:** 100% of load rating at 104°F (40°C) for any load from 0.5 lagging to 0.9 leading
2. **Voltage Regulation:**
    - ±1% RMS average for a balanced, three-phase load
    - ±2% for 100% unbalanced load for line-to-line imbalances

3. **Voltage Adjustment Range:** ±5% for line drop compensation adjustable by factory service personnel
4. **Voltage Distortion:** 1% total harmonic distortion (THDv) maximum into a 100% linear load, 3% THD maximum into a 100% non-linear load with crest factor ratio of 3:1
5. **Frequency Regulation:**
   - Synchronized to bypass: ±2.0Hz default setting, (adjustable by factory service personnel)
6. **Bypass Frequency Synchronization Range:** ±0.5, 1.0, 2.0, 3.0 Hz, adjustable by factory service personnel, ±2.0 Hz default setting
7. **Frequency Slew Rate:** 0.1 to 3 Hz/sec, 0.6 Hz/sec default setting
8. **System Efficiency (defined as output kW/input kW at rated lagging load power factor; and up to values listed below [select kVA rating for this specification]):**

kVA Rating	Maximum Efficiency
30	96.6%
40	96.6%
50	96.6%
75	96.8%
100	96.8%
125	96.9%
150	96.9%
175	96.6%
200	96.6%
225	96.5%
250	96.6%

9. **Phase Imbalance:**
   - **Balanced loads:** 120° ±0.5°
   - **100% unbalanced loads:** 120° ±1.5°
10. **Voltage Transients (average of all three phases):**
    - 0-100% or 100-0%
    - Response: Meets ITIC and CBEMA Curve Requirements
    - Complies with IEC/EN 62040-3: 2010 Figure 2 Curve 1, Class 1
    - Transient Voltage Deviation, RMS: 5%
    - Recovers within 60ms

11. **Overload at Full Output Voltage with ±1% voltage regulation:**
    - 100% continuously
    - 105% - 110% of full load for 60 minutes at 104°F (40°C) ambient
    - 110% - 125% of full load for 10 minutes at 104°F (40°C) ambient
    - 125% - 150% of full load for 60 seconds at 104°F (40°C) ambient
    - >150% of full load for a minimum of 200 milliseconds at 104°F (40°C) ambient

1.4.2 Grounding

The UPS chassis shall have an equipment ground terminal.

1.5 Environmental Conditions

The UPS shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics:

1. **Operating Ambient Temperature**
    - **UPS:** 32°F to 104°F (0°C to 40°C) without derating
    - **VRLA Battery**: 77°F (25°C), ±5°F (±3°C)
    - **Samsung Lithium-ion Battery:** 64°F to 82°F (18°C to 28°C)
2. **Storage/Transport Ambient Temperature**

    -4°F to 158°F (-20°C to 70°C)
3. **Relative Humidity**

    0 to 95%, non-condensing
4. **Altitude**
    - **Operating:** To 4922 ft. (1500m) above Mean Sea Level without derating (compliant with IEC/EN 62040-3 at altitudes exceeding 1500m) Consult factory for derating above 4922 ft. (1500m) elevation.
    - **Storage/Transport:** To 50,000 ft. (15,000m) above Mean Sea Level
5. **Audible Noise Level**

Unit Size	Noise/Load, dB	
	100% Load	50% Load
30-50kVA	63.2	60.5
75-100kVA	66.1	62
125-150kVA	67.1	62.9
175-200kVA	68.5	63.4
225-250kVA	68.7	63.8
Measured 4.6 ft. (1.4m) from the surface of the unit.		

1.6 Submittals

1.6.1 Proposal Submittals

Submittals with the proposal shall include:

- Descriptions of equipment to be furnished, including deviations from these specifications.
- Document stating compliance with FCC requirements.
- Document stating listing to UL, including edition used for listing.
- Document showing compliance with required SCCR and labeling.
- System configuration with single-line diagrams.
- Detailed layouts of customer power and control connections.
- Functional relationship of equipment, including weights, dimensions and heat dissipation.
- Information to allow distribution system coordination.
- Size and weight of shipping units to be handled by contractor.

1.6.2 Order Submittals

Submittals supplied at time of order shall include:

- All of the documentation presented with the proposal, per Section 1.5.1.
- Detailed installation drawings including all terminal locations.
- Interconnect wiring diagrams showing conduit wiring with terminal numbers for each wire.

1.6.3 UPS Delivery Submittals

Submittals upon UPS delivery shall include:

- A complete set of submittal drawings.
- Two (2) sets of instruction manuals. Manuals shall include a functional description of the equipment, safety precautions, instructions, step-by-step operating procedures and routine maintenance guidelines, including illustrations.

1.7 Warranty

1.7.1 UPS Warranty

The UPS manufacturer shall warrant the unit against defects in workmanship and materials for 12 months after initial startup or 18 months after the shipping date, whichever comes first.

1.7.2 Warranty – End User

Warranties associated with items not manufactured by the UPS supplier but included as part of the system shall be passed through to the end user.

1.8 Quality Assurance

1.8.1 Manufacturer's Qualifications

A minimum of 20 years' experience in the design, manufacture and testing of solid-state UPS systems shall be required.

The quality system for the engineering and manufacturing facility shall be certified to conform to Quality System Standard ISO 9001 for the design and manufacture of power protection systems for computers and other sensitive electronics.

1.8.2 Factory Testing

Before shipment, the manufacturer shall fully and completely test the UPS unit to ensure compliance with the specification.

The UPS unit shall be tested at the system-specified capacity. Testing shall be done using load banks at part-load and the full kW rating of the unit. Operational discharge and recharge tests to ensure guaranteed rated performance. System operations such as startup, shutdown and transfers shall be demonstrated.

A certified copy of the test results shall be available for each system as indicated on the order.

2.0 PRODUCT

2.1 Fabrication

2.1.1 Materials

All materials of the UPS shall be new, of current manufacture, high grade and shall not have been in prior service except as required during factory testing. All active electronic devices shall be solid-state. All power semiconductors shall be sealed. Control logic and fuses shall be physically isolated from power train components to ensure operator safety and protection from heat. All circuit boards shall be conformal coated. All bus bars shall be copper and plated.

2.1.2 UPS Internal Wiring

Wiring practices, materials and coding shall be in accordance with the requirements of the National Electrical Code, OSHA and applicable local codes and standards. All bolted connections of busbars, lugs and cables shall be in accordance with requirements of the National Electrical Code and other applicable standards. All electrical power connections shall be torqued to the required value and marked with a visual indicator.

2.1.3 Field Wiring

All field wiring power connections shall be tin-plated copper busbars for connection integrity. Busbars shall have adequate space to allow two-hole, long-barrel, compression type lugs forming a permanent connection between field wiring and field-installed lugs.

Provisions shall be made in the cabinets to permit installation of input, output and external control cabling using raceway or conduit. Provision shall be made for top and bottom access to input, output, bypass and DC connections. In conformance with the NEC, connection cabinets shall provide for adequate wire bend radius.

2.1.4 Construction and Mounting

The UPS shall be in NEMA Type 1 enclosures (IEC 60529 IP20), designed for floor mounting. The UPS shall be structurally adequate and have provisions for hoisting, jacking and forklift handling. Maximum cabinet height shall be 78.7 in. (2000mm).

The UPS shall be NEMA Type 1-compliant, with front doors open to enable safe change of air filters without the need for shutdown.

2.1.5 Cooling

Adequate ventilation shall be provided to ensure that all components are operated well within temperature ratings.

Temperature sensors shall be provided to monitor the UPS's internal temperature. Upon detection of temperatures in excess of the manufacturer's recommendations, the sensors shall cause audible alarms to be sounded and visual alarms to be displayed on the UPS control panel. Air filters shall be located at the point of air inlet and shall be changeable. No service clearance or ventilation shall be required in the rear of the system.

2.2 Equipment

2.2.1 UPS System

The UPS system shall consist of an IGBT power factor-corrected rectifier, DC-DC converter and three-phase, transformer-free inverter, bypass static transfer switch, bypass synchronizing circuitry, protective devices and accessories as specified. The specified system shall also include a battery disconnect breaker and battery system.

2.2.2 Output Protection

The UPS shall be protected against sudden changes in output load and short circuits at the output terminals. The UPS shall have built-in protection against permanent damage to itself and the connected load for all predictable types of malfunctions. Fast-acting, current-limiting devices shall be used to protect against cascading failure of solid-state devices. Internal UPS malfunctions shall cause the module to trip off-line with minimum damage to the module and provide maximum information to maintenance personnel regarding the reason for tripping off-line. The load shall be automatically transferred to the bypass line uninterrupted for an internal UPS malfunction. The status of protective devices shall be indicated on a graphic display screen on the front of the unit.

2.3 Components

2.3.1 Rectifier

The term rectifier shall denote the solid-state equipment and controls necessary to convert alternating current to regulated direct current to supply the inverter and charge the battery. The DC output of the rectifier shall meet the input requirements of the inverter without the battery being connected.

1. **Input Current Harmonic Distortion:** The rectifier shall actively control and reduce input current distortion over the full operating range of the UPS without the need for an additional passive input filter. Input current THD shall be less than 5% at rated load and nominal voltage in double-conversion mode.
2. **Dynamic Current Input Limit Reduction:** The rectifier, in conjunction with the other UPS controls and circuitry, shall adjust the current demanded for battery charging as a function of UPS wattage load and input voltage level.

2.3.2 DC-DC Converter

The term DC-DC converter shall denote the equipment and controls to regulate the output of the rectifier to the levels appropriate for charging the battery and to boost the battery voltage to the level required to operate the inverter. The DC-DC converter shall be solid-state, capable of providing rated output power and, for increased performance, shall be a pulse width-modulated design and shall utilize insulated gate bipolar transistors (IGBTs). The DC-DC converter shall control charging of the battery. The AC ripple voltage of the charger DC shall not exceed 1% RMS of the float voltage.

1. **Battery Equalize Charge:** A manually initiated equalize charge feature shall be provided to apply an equalize voltage to the battery. The duration of equalize charge time shall be adjustable from 8 to 30 hours. A method shall be available to deactivate this feature for valve regulated battery systems.
2. **Stop Battery Charging Function:** Battery charging may be stopped by a shunt trip of the battery cabinet breaker when overtemperature is sensed in the battery cabinet, on generator or when environmental contact is closed.
3. **Overvoltage Protection:** There shall be DC overvoltage protection so that if the DC voltage rises to the pre-set limit, the UPS shall shut down automatically and initiate an uninterrupted load transfer to bypass or shall disconnect the battery via the DC breaker(s) in the battery string.
4. **Temperature-Compensated Charging:** The UPS shall adjust the battery charging voltage based on the battery temperature reported from external battery temperature sensors. When multiple sensors are used, the voltage shall be based on the average temperature measured. Excessive difference in the temperature measurements shall be reported and the charging voltage adjusted to protect the batteries from excessive current.

5. **Battery Load Testing:** The UPS shall be capable of performing battery load testing under operator supervision. To accomplish this, the rectifier shall reduce charging voltage to force the batteries to carry the load for a short time. If the curve of battery voltage drop indicates diminished battery capacity, the UPS shall display an alarm message. If the voltage drop indicates battery failure, the UPS shall terminate the test immediately and annunciate the appropriate alarms.

2.3.3 Inverter

The term inverter shall denote the equipment and controls to convert direct current from the rectifier or battery via the DC-DC converter to precise alternating current to power the load. The inverter shall be solid-state, capable of providing rated output power and, for increased performance, the inverter shall be a pulse-width-modulated design and shall utilize insulated gate bipolar transistors (IGBTs). To further enhance reliable performance and efficiency, the inverter shall not require an inverter output series static switch/isolator for the purposes of overload or fault isolation or transfers to bypass.

1. **Overload Capability:** The inverter shall be able to withstand an overload across its output terminals while supplying full rated voltage of up to 150% for 60 seconds. The inverter shall be capable of at least 170% current for short-circuit conditions including phase-to-phase, phase-to-ground and three-phase faults. After the fault is removed, the UPS shall return to normal operation without damage. If the short circuit is sustained, the load shall be transferred to the bypass source and the inverter shall disconnect automatically from the critical load bus.
2. **Output Frequency:** The inverter shall track the bypass continuously, providing the bypass source maintains a frequency of 60Hz ±1% (0.6 Hz).
3. **Phase-to-Phase Balance:** The inverter shall provide a phase-to-phase voltage displacement of no worse than ±3% with a 100% unbalanced load.
4. **Inverter Fault Sensing and Isolation:** The UPS shall be provided with a means to detect a malfunctioning inverter and isolate it from the critical load bus to prevent disturbance of the critical load voltage beyond the specified limits.
5. **Battery Protection:** The inverter shall be provided with monitoring and control circuits to protect the battery system from damage due to excessive discharge. Inverter shutdown shall be initiated when the battery voltage has reached the end of discharge voltage. The battery end-of-discharge voltage shall be calculated and automatically adjusted for partial load conditions to allow extended operation without damaging the battery. Automatic shutdown based on discharge time shall not be acceptable.

2.3.4 Inverter Bypass Operation

When maintenance is required or when the inverter cannot maintain voltage to the load due to sustained overload or malfunction, a bypass circuit shall be provided to isolate the inverter output from the load and provide a path for power directly from an alternate AC (bypass) source. The UPS control system shall constantly monitor the availability of the inverter bypass circuit to perform a transfer. The inverter bypass circuit shall consist of a continuous duty bypass static switch and an overcurrent protection device to isolate the static bypass switch from the bypass utility source. The bypass static switch shall denote the solid-state device incorporating SCRs (silicon-controlled rectifiers) that can automatically and instantaneously connect the alternate AC source to the load.

1. **Static Bypass Switch Rating:** The static bypass switch shall be rated for continuous duty operation at full rated load for highest reliability without the use of mechanical devices, such as those used with a momentary rated device.
2. **Manual Load Transfers:** A manual load transfer between the inverter output and the alternate AC source shall be initiated from the control panel. Manually initiated transfers shall be make-before-break, utilizing the inverter and the bypass static switch.

3. **Automatic Load Transfers:** An automatic load transfer between the inverter output and the alternate AC source shall be initiated if an overload condition is sustained for a period in excess of the inverter output capability or due to a malfunction that would affect the output voltage. Transfers caused by overloads shall initiate an automatic retransfer of the load to the inverter only after the load has returned to a level within the rating of the inverter source and the alarm has been acknowledged.
4. **Back-Feed Protection:** As required by UL1778 and CSA, the static transfer switch shall not back-feed UPS power to the bypass distribution system while the UPS is operating on battery during a bypass power outage. The purpose of this requirement is to prevent the risk of electrical shock on the distribution system when the normal source of power is disconnected or has failed. If a shorted SCR is detected, the static transfer switch shall be isolated by automatically tripping the upstream bypass circuit breaker and an alarm message shall be annunciated at the UPS control panel. The load shall remain on conditioned and protected power after detection of a shorted SCR and isolation of the bypass static switch.
5. **Active ECO-Mode:** When selected, this mode of operation shall transfer the load to the bypass source and maintain it there as long as the bypass source frequency, slew rate and voltage are within the adjusted operating parameters. While in this mode, the inverter shall remain operating to be able to instantaneously assume the load without interrupting the output voltage. Should the bypass source go outside the adjusted limits, the bypass static switch shall turn Off, isolating the load from the bypass while the inverter assumes the full critical load. The load shall be transferred from the bypass source to the inverter while maintaining the output voltage within the ITIC and CBEMA curves.

2.3.5 Display and Controls

1. **UPS Control Panel:** The UPS shall be provided with a microprocessor-based control panel for operator interface (may also be referred to as User Interface, or UI) to configure and monitor the UPS. The control panel shall be located on the front of the unit where it can be operated without opening the hinged front door. A backlit, menu-driven, full-graphics, color touchscreen liquid crystal display shall be used to display system information, metering information, a one-line diagram of the UPS and battery, active events and event history.

   No mechanical push buttons shall be used.
2. **Logic:** UPS system logic and control programming shall reside in a microprocessor-based control system with nonvolatile flash memory. Rectifier, inverter and system control logic shall utilize high-speed digital signal processors (DSPs). CANbus shall be used to communicate between the logic and the User Interface as well as the options. Switches, contacts and relays shall be used only to signal the logic system as to the status of mechanical devices or to signal user control inputs. Customer external signals shall be isolated from the UPS logic by relays or optical isolation.
3. **Metered Values:** A microprocessor shall control the display and memory functions of the monitoring system. All three phases of three-phase parameters shall be displayed simultaneously. All voltage and current parameters shall be monitored using true RMS measurements for accuracy to ±3% of voltage, ±5% AC current. The following parameters shall be displayed:
   - Input voltage, line-to-line
   - Input current per phase
   - Input frequency
   - Input apparent power (kVA)
   - Battery voltage
   - Battery charging/discharging current

- Output voltage, line-to-line
- Output frequency
- Bypass input voltage, line-to-line
- Bypass input frequency
- Load current
- Load real power (kW), total and percentage
- Load apparent power (kVA), total and percentage
- Battery temperature

4. **Power Flow Indications:** A power flow diagram shall graphically depict whether the load is being supplied from the inverter, bypass or battery and shall provide, on the same screen, the status of the following components:
   - AC Input Circuit Breaker (optional)
   - Battery Circuit Breaker, each breaker connection of complete battery complement, complete disconnection and partial connection (one or more, but not all breakers open.)
   - Maintenance Bypass Status
5. **Main Display Screen The following UPS status messages shall be displayed:**
   - Rectifier (Off / Soft Start / Main Input On / Battery Input On)
   - Input Supply (Normal Mode / Battery Mode / All Off)
   - Battery Self Test (True / False)
   - Input Disconnect (Open / Closed)
   - EPO (True / False)
   - Charger (On / Off)
   - Output Disconnect (Open / Closed)
   - Maint. Disconnect (Open / Closed)
   - Bypass Disconnect (Open / Closed)
   - Inverter (Off / Soft Start / On)
   - Bypass (Normal / Unable To Trace / Abnormal)
   - Output Supply (All Off / Bypass Mode / Inverter Mode / Output Disable)
   - Inverter On (Enable / Disable)
6. **HMI Control Buttons—Buttons shall be provided to start and stop the inverter.**

   Other buttons shall be provided to reset faults and silence the alarm buzzer.
7. **Event Log:** This menu item shall display the list of events that have occurred recently while the UPS was in operation. The Event Log shall store up to 2048 events, with the oldest events being overwritten first if the log's capacity is reached.
8. **Battery Status Indicator:** A battery status indicator shall display DC alarm conditions, temperature, battery state of charge, the present battery voltage and battery time remaining during discharge.

The UPS shall provide the operator with controls to perform the following functions:

- Configure and manage manual battery test
- Start battery test
- Monitor test status and progression
- Stop battery test
- Battery test status

9. **Alarms—The following alarm messages shall be displayed:**
    - Mains Voltage Abnormal
    - Mains Undervoltage
    - Mains Freq. Abnormal
    - Charger Fault
    - Battery Reversed
    - No Battery
    - Parallel Comm. Fail
    - Bypass Unable To Track
    - Bypass Abnormal
    - Inverter Asynchronous
    - Fan Fault
    - Control Power Fail
    - Output Overload
    - Bypass Phase Reversed
    - Transfer Time-Out
    - Load Sharing Fault
    - Bypass Over Current.
10. **Controls—System-level control functions shall be:**
    - Start Inverter (and transfer to inverter)
    - Stop Inverter (after transferring to bypass)
    - Startup Screen
    - Configure Manual Battery Test
    - Initiate Manual Battery Test
    - System Settings (Time, Date, Language, Password
    - Alarm Silence Command
    - Fault Reset Command
    - ECO mode

11. **Manual Procedures:** Load Transfers: HMI buttons (START INVERTER, STOP INVERTER) shall provide the means for the user to transfer the load to bypass and back on UPS.

2.3.6 Self-Diagnostics

Event Log File - The control system shall maintain a log of the event conditions that have occurred during system operation. Each log shall contain the event name, event time/date stamp and a set/clear indicator.

2.3.7 Remote Monitoring and Integration Capabilities

1. **Vertiv™ LIFE™ Services:** The UPS manufacturer shall provide as an option LIFE services, which provides 24x7 continuous monitoring of events and parametric data, event and data analysis reports and dispatch of factory-trained field service personnel. The UPS shall be able to initiate periodic and critical event-driven communication with a remote service center to transfer event and parametric data for analysis and action. The remote service center shall be staffed with factory-trained service personnel who are capable of receiving, analyzing and interpreting the communicated events and data. The remote service center personnel shall also be capable of dispatching factory-trained field service personnel to the location of the UPS.
2. **Communication Cards:** The UPS can be equipped with up to three optional communication card(s) including:
    a. Optional Vertiv™ Liebert® IntelliSlot Unity card providing Web-based UPS monitoring and management capabilities, Vertiv™ LIFE Services delivery and two of the following third-party open protocols:
        - SNMP protocols (v1, v2, v3)
        - Modbus RTU or Modbus TCP
        - BACnet MSTP or BACnet IP

Note: Modbus RTU and BACnet MSTP cannot both be enabled simultaneously.

    b. Optional Vertiv™ Liebert® SiteScan™ Interface card to interface with Liebert® SiteScan™ Web software.
    c. Liebert® IntelliSlot Unity, Vertiv™ LIFE™ card included to enable Vertiv™ LIFE™ Services when the optional Liebert® IntelliSlot Unity card is not purchased.
3. **Output Alarm Contacts:** Dry contact outputs shall be provided for Summary Alarm, Bypass Active, Low Battery and AC Input Failure.
4. **Customer Input Contacts:** The UPS shall have four discrete input contacts available for the input and display of customer-provided alarm points or to initiate a pre-assigned UPS operation. Each input can be signaled by an isolated, external, normally open contact. When an assembly is selected as a pre-assigned UPS operation, the following actions shall be initiated:
    - **On Generator:** Provides selectable choices to enable or disable battery charging, and enable or disable ECO Mode operation while on generator.
    - **Transfer to Bypass**: Manual command to transfer from inverter operation to static bypass operation.
    - **Fast Power Off:** Emergency Module Off (EPO) command to stop UPS operation.
    - **Acknowledge Fault**: Acknowledge a UPS alarm condition and present faults will be reset.
    - **Bypass/Inverter Off:** Emergency Power Off (EPO) command to stop UPS operation.
    - External Maintenance Bypass Breaker (MBB) status (open or closed)

2.3.8 Battery Disconnect Breaker

The battery cabinet shall have a properly rated circuit breaker (600VDC) to isolate it from the Vertiv™ Liebert® EXM UPS. This breaker shall be in a separate NEMA-1 enclosure or in a matching battery cabinet. When this breaker is open, there shall be no battery voltage in the UPS enclosure. The UPS shall be automatically disconnected from the battery by a shunt trip of the battery cabinet breaker when signaled by other control functions.

2.3.9 Maintenance Bypass Cabinet (Optional)

The UPS system shall incorporate a matching cabinet to house a wraparound maintenance bypass with the following features:

- 2, 3, or 4 breakers for complete electrical isolation of the UPS with system voltage of 480VAC, 3W+Gnd input/output only, no integral output distribution
- Optional Kirk Key Interlock interface with Solenoid Key Release Unit (SKRU)

2.3.10 Valve-Regulated, Lead Acid Battery (Optional)

- 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. Matching Battery Cabinet

- The battery cabinet shall consist of sealed, valve-regulated batteries, a circuit breaker for isolating the battery 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.

2. Optional Battery Monitoring System

The battery system shall be provided with an Vertiv™ Liebert ® Alber™ comprehensive battery monitoring system. The system shall provide predictive on-line test, analysis and remote monitoring using patented DC resistance measurements.

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
- Individual 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.

2.3.11 Optional Accessories and Features

1. **Load Bus Sync:** The Load Bus Sync (LBS) shall enable two independent single-module UPS units to stay in sync when operating on battery or unsynchronized input sources. The LBS shall determine the primary/secondary relationship between UPS units. The LBS shall be installed within each single-module UPS.
2. **Communication Card:** A communication card shall provide Web-based UPS monitoring and management capabilities and one or two of the following remote monitoring protocols: SNMP (v1, v2, v3), Modbus or BACnet for remote monitoring.
3. **Relay Contact Card:** A relay contact card shall provide output dry contact signals communicating the following UPS states: Summary Alarm, Bypass Active (On Bypass), Low Battery, AC Input Failure (UPS Fault) and on UPS.
4. **Vertiv™ Liebert® SiteScan™ Communication Card:** The Liebert® SiteScan™ communication card shall provide a connection to a Vertiv™ Liebert® SiteLink-E, allowing Liebert® SiteScan™ Web to monitor and control the UPS.
5. **Seismic Anchorage Kits:** Seismic anchorage kits shall be provided with the UPS unit, and if included the optional matching battery cabinet, for use in seismic restraint as required for IBC 2012 or OSHPD certification

3.0 STORED ENERGY SYSTEMS

The UPS system shall be provided with a stored energy system that shall comply with the specifications of:

- Flooded-Cell Battery System,
- Valve-Regulated, Lead-Acid Battery System,
- Lithium-Ion Battery System
- Vycon Flywheel Energy Storage System.

Specifications describing the requirements for the customer-specified stored energy system are contained in SL-25418GS, available at the Vertiv Web site.

4.0 EXECUTION

4.1 Field Quality Control

The following inspections and test procedures shall be performed by factory-trained field service personnel during the UPS startup.

1. Visual Inspection

- Inspect equipment for signs of damage.
- Verify installation per drawings supplied with installation manuals or submittal package.
- Inspect cabinets for foreign objects.
- Verify that neutral and ground conductors are properly sized and configured per Vertiv requirements as noted in Vertiv drawings supplied with installation manuals or submittal package.
- Inspect each battery jar for proper polarity.
- Verify that all printed circuit boards are configured properly.

2. Mechanical Inspection

- Check all control wiring connections for tightness.
- Check all power wiring connections for tightness.
- Check all terminal screws, nuts and/or spade lugs for tightness.

3. Electrical Inspection

- Check all fuses for continuity.
- Confirm input and bypass voltage and phase rotation are correct.
- Verify control transformer connections are correct for voltages being used.
- Ensure connection and voltage of the battery string(s).

4.2 Unit Startup

- Energize control power.
- Perform control/logic checks and adjust to meet Vertiv specification.
- Verify DC float and equalize voltage levels.
- Verify DC voltage clamp and overvoltage shutdown levels.
- Verify battery discharge, low battery warning and low battery shutdown levels.
- Verify fuse monitor alarms and system shutdown.
- Verify inverter voltages and regulation circuits.
- Verify inverter/bypass sync circuits and set overlap time.
- Perform manual transfers and returns.
- Simulate utility outage at no load.
- Verify proper recharge.

4.3 Manufacturer's Field Service

1. **Service Personnel:** The UPS manufacturer shall directly employ a nationwide service organization, consisting of factory-trained field service personnel dedicated to the startup and maintenance of UPS and power equipment.

   The manufacturer shall provide a national dispatch center to coordinate field service personnel schedules. One toll-free number shall reach a qualified support person 24 hours a day, 7 days a week and 365 days a year. If emergency service is required, on-site response time shall be 4 hours or less within 150 miles of a Vertiv Services center.

   Two local customer engineers shall be assigned to the site with a regional office as a backup. Escalation procedures shall be in place to notify Power Technical Support if a site is not functioning within 24 hours.

2. **Automated Site Monitoring:** The UPS manufacturer shall provide as an option an automated site monitoring service. This service shall be staffed by a qualified support person 24 hours a day, 7 days a week and 365 days a year. At the detection of an alarm within the UPS, the controls shall initiate communication with the monitoring service. The monitoring service shall be capable of interpreting the communicated alarms to allow dispatch of a service engineer.

3. **Replacement Parts Stocking:** Parts shall be available through an extensive network to ensure round-the-clock parts availability throughout the country.

   Spare parts shall be stocked by local field service personnel with backup available from national parts centers and the manufacturing location. A Customer Support Parts Coordinator shall be on call 24 hours a day, 7 days a week, 365 days a year for immediate parts availability.

4. **Maintenance Contracts:** A complete offering of preventive and full-service maintenance contracts for both the UPS system and battery system shall be available.