Vertiv™ Liebert® NX UPS
GUIDE SPECIFICATIONS
For a 225-600kVA
Multi-Module Uninterruptible Power System

1.0 GENERAL

1.1 Summary

These specifications describe requirements for an Uninterruptible Power System (UPS) consisting of multiple UPS modules operating in parallel for capacity or redundancy. The UPS shall automatically maintain AC power within specified tolerances to the critical load, 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. It 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, Fourth 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 a dual-input unit without damage per the criteria in ANSI C62.41, category B3 (6kV). The manufacturer shall provide evidence of compliance upon request.
- The UPS shall comply with FCC Rules and Regulations, Part 15, Subclass B, Class A. 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 and Battery Cabinets shall be certified to the International Building Code (IBC) 2012 with seismic performance of S_{ds}=2.27, I_p=1.5 and z/h=1.0, Optional seismic anchorage shall be available from the UPS and battery manufacturer(s) for use in compliance with this certification. The UPS module shall be pre-certified by OSHPD.

1.3 System Description

1.3.1 Design Requirements

- The UPS shall be sized to provide a minimum of ____ kVA/kW output (unity load power factor rating)
- The UPS shall be able to supply all required power to full rated output kVA loads with power factor from 0.7 lagging to 0.9 leading.
- 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 except in a high resistance ground requirement (see below).
- The rectifier AC input and bypass AC input may be fed from separate AC sources.
- The battery shall support the UPS at 100% rated kW load for at least _____ minutes at 77°F (25°C) at startup.
- 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.
- The UPS shall be capable of operating in a High Resistance Ground environment, and shall provide notification when a fault to ground occurs on its output. Leakage current shall not exceed 1.5 amps.

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. Energy Optimization Mode (Active 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. Emergency

   Upon failure of utility AC power, the critical AC 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 battery. This shall be an automatic function and shall cause no interruption to the critical AC load.

5. Bypass

   If the UPS must be taken out of service for maintenance or repair, the bypass static switch shall transfer the load to the bypass source. The transfer process shall cause no interruption in power to the critical AC 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 for maintenance, it shall be disconnected from the DC-DC converter by means of an external disconnect circuit breaker. 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 with either of the following conditions occurring:

- Any altitude within the specified operating range up to 3300 ft. (1000m) elevation
- Any ambient temperature within the specified operating range of 32°F to 104°F (0°C to 40°C)

1.3.4 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

   +10%, -30% of nominal (minimum -15% at nominal load.) The UPS shall operate without discharging the battery at 70% of full nominal load with voltage down to -30% of nominal.

3. Frequency Range

   60Hz, adjustable by service personnel up to ±3.6Hz in 0.12Hz increments

4. Rectifier Walk-In

   0% to 100% of full rated load over 2.5-90 seconds (adjustable) with full rectifier power.

5. Rectifier Start Delay

   Programmable from 1-180 seconds

6. Max Inrush Current

   UPS inrush current not to exceed 1.5 times rated input current.

7. Power Factor

   Minimum 0.99 at full load with nominal input voltage

8. Current Distortion

   Less than 3% input current THD at rated load and nominal voltage in double-conversion mode

9. Surge Protection

   Sustains input surges without damage per criteria listed in ANSI C62.41, category B3 (6kV)

10. Short Circuit Current Withstand Rating

    Units shall carry as standard 100 kA Short Circuit Withstand Rating (SCWR). 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.

1.3.5 AC Output

1. Load Rating: 100% load rating at 104°F (40°C) for 8 hours for any load from 0.9 leading to 0.7 lagging; 100% of load rating continuous at 95°F (35°C).
2. Voltage Regulation:
   - ±1% RMS average for a balanced three-phase load
   - ±3% for 100% unbalanced load for line-to-line imbalances
3. Voltage Adjustment Range

   ±5% for line drop compensation adjustable by factory service personnel.
4. Frequency Regulation:
   - Synchronized to bypass: ±1.2Hz default setting, adjustable by factory service personnel)
   - Synchronized to internal clock 0.06Hz
5. Efficiency

   Defined as output kW/input kW at rated lagging load power factor; and not less than the values listed below (Select kVA rating for this specification. Values are for single modules.):

kVA Rating	25% Load	50%Load	75% Load	100% Load
225	92%	94.8%	95.2%	95%
250	92.7%	95%	95.3%	95%
300	94%	95.2%	95.3%	95%
400	92.5%	94.7%	95.2%	95.3%
500	93.5%	95%	95.3%	95%
600	93.8%	95.2%	95.3%	94.6%

6. Phase Imbalance:
   - Balanced loads 120° ±1°
   - 100% unbalanced loads 120° ±3°
7. Voltage Transients (average of all three phases):
   - 0-100% or 100-0%

     Response: Meets IEC 62040-3: 2010 Figure 2 Curve 1, Class 1

     Meets ITIC and CBEMA Curve Requirements
   - 10-100% or 100-10%
   - Transient Voltage Deviation, RMS: ≤5%
   - Step Load Transient Recovery (linear loads): ±1% of nominal within four line cycles

8. Voltage Harmonic Distortion:
    - Maximum 1% RMS total (100% resistive load)
9. Overload at Full Output Voltage with ±1% Voltage Regulation:
    - 100% continuously
    - 125% of full load for 10 minutes at 95°F (35°C) ambient
    - 150% of full load for a minimum of 60 seconds at 95°F (35°C) ambient
10. Current Limit: 300% nominal current including a bolted fault condition without bypass for up to 10 milliseconds and 150% for <5 seconds.
11. Fault Clearing:
    - Inverter only: 200% of normal full load current for 200 milliseconds or 150% of normal full load current for <5 seconds (when bypass is not available).
    - Bypass available: 500% for 600 milliseconds operation when bypass is available.
    - The UPS shall supply current from both the bypass and the inverter until the inverter overload time expires, and then shall continue to supply current from the bypass to clear the fault.

1.3.6 Grounding

The UPS chassis shall have an equipment ground terminal.

1.4 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) for up to 8 hours without derating; up to 95°F (35°C) continuously without derating
    - **Battery:** 77°F (25°C), ±5°F (±3°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 3300 ft. (1000m) above Mean Sea Level without derating (compliant with IEC/EN 62040-3 at altitudes exceeding 1000m)

      Consult factory for derating above 3300 ft. (1500m) elevation.
    - **Storage/Transport:** To 50,000 ft. (15,000m) above Mean Sea Level
5. Audible Noise Level
    - 70dBA measured 5 ft. (1.5m) from the surface of the unit

1.5 Parallel Systems

1. Parallel Configurations

   Up to six (6) UPS module outputs may be connected together in parallel to provide up to 6X maximum output for capacity and 5X maximum output with redundancy.

2. Inter-Module Communications

   The UPS module shall communicate via a redundant cable system based on a bi-directional loop such that any single break or disconnection of the cable system shall generate an alarm, but shall not interfere with the parallel operation of the system.

3. Paralleling Switchgear

   The outputs of the UPS modules shall be connected to an output switchboard containing a common output bus. The switchboard shall be provided with magnetic or thermal-magnetic Module Output Breakers for each module to permit isolating any module from the output bus.

4. Current Sharing

   When multiple UPS modules are connected in parallel and powering a common load, each UPS module output current shall not differ by more than 5% of the rated full load current of one UPS module. In cases where cable lengths can vary widely, a matching cabinet with sharing control inductors in the bypass path shall be available.

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 produced for the order shall include:

- All of the documentation presented with the proposal.
- 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 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 test each UPS module fully and completely to ensure compliance with the specification.

Operational discharge and recharge tests shall be performed to ensure guaranteed rated performance.

(**Optional**) All UPS modules shall be connected and tested at the system-specified capacity. Testing shall be done using load banks at both part-load and the full kW rating of the unit and the system. System operations such as startup, shutdown and transfers shall be demonstrated.

A certified copy of 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 electronic components shall be accessible from the front without removing sub-assemblies for service access.

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 Electric 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 to 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, 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.in. (1990mm).

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. An internal, factory-mounted sensor for room ambient temperature shall be provided to give an alarm if the temperature of the inlet air to the UPS is above specified limits. 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.

1. **Surge Protection**

   The UPS shall have built-in protection against: surges, sags and overcurrent from the AC source. The protection shall meet the requirements of ANSI C62.41 B3 including:

   - 6kV, 100kHZ ring wave, line-to-line, line-to-neutral, line-to-ground and neutral-to-ground
   - 6kV, combined wave, line-to-line, line-to-neutral, line-to-ground and neutral-to-ground

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 3% at rated load and nominal voltage in double-conversion mode.

2. **Input Current Walk-In**

   The rectifier/charger shall provide a feature that limits, during the transfer from battery mode to on-line mode, the total initial power requirement at the input terminals to 0% of rated load and gradually increases power to 100% of full rating over the 2.5 to 90-second (adjustable) time interval with full rated rectifier power.

3. **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 Recharge**

   In addition to supplying power for the load, the rectifier/charger shall be capable of supplying a minimum of 5% of the module full load power rating for recharging the battery. After the battery is recharged, the rectifier/charger shall maintain the battery at full charge until the next emergency operation.

2. **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 0 to 200 hours. A method shall be available to deactivate this feature for valve regulated battery systems.

3. **Thermal Runaway Protection and Battery Charger Control**

   The UPS shall provide temperature compensated charging. This function requires that the UPS be equipped with temperature sensors in each cabinet and an interface scheme provided by the UPS manufacturer. The UPS shall adjust the battery charging voltage based on the battery temperature reported from external battery temperature sensors. Temperature sensors shall be monitored for faulty measurements and shall be ignored if a fault is detected to prevent overcharging or undercharging the battery. 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.In addition, the UPS shall be programmable so that a battery overtemperature condition can be detected in any single battery cabinet and a three-stage response shall be initiated:

   - When the temperature in the cabinet reaches 100.4°F (38°C), temperature compensation shall be stopped and an alarm generated.
   - When the temperature in the cabinet reaches 109.4°F (43°C), the charger will shut off completely and the circuit breaker for any individual overtemperature battery cabinet or string may be opened, isolating that cabinet or string only and retaining reduced battery protection for the UPS. This condition shall be displayed on the UPS HMI screen and in the event log.
   - Once the breaker on the affected cabinet or string has been tripped, the UPS shall resume normal charging with the remaining battery cabinets or strings.

   The system shall meet the requirements of the IFC 2012 for preventing thermal runaway battery protection for the UPS. This condition will be displayed on the UPS HMI screen, and in the event log.

   Battery charging may also be stopped by an external signal that may be activated by a contact closure to indicate “on generator” operation or other condition (including battery overtemperature, presence of excessive hydrogen, or failure of the room ventilator fan) under which battery charging is undesirable or inadvisable.

4. **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.

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 sustain an overload across its output terminals while supplying full rated voltage for up to 150% for 60 seconds. The inverter shall be capable of at least 200% 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). The inverter shall change its frequency (slew rate) at less than 1Hz per second to maintain synchronous operation with the bypass. This shall allow make-before-break manual or automatic transfers. If the bypass fails to maintain proper frequency, the inverter shall revert to an internal oscillator, which shall be temperature compensated and shall hold the inverter output frequency to 0.1% from the rated frequency for steady-state and transient conditions. Drift shall not exceed 0.1% during any 24-hour period. Total frequency deviation, including short time fluctuations and drift, shall not exceed 0.1% from the rated frequency.

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. **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

For times 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 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 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 as 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. **Momentary Overloads**

   In the event of a load current inrush or branch load circuit fault in excess of the inverter rating, the bypass static switch shall connect the alternate AC source to the load for at least 600 milliseconds, allowing up to 1000% of the normal rated output current to flow. Output voltage shall be sustained to the extent the alternate AC source capacity permits. If the overload condition is removed before the end of the 600-millisecond period, the bypass static switch shall turn Off and the load shall remain on inverter power. If the overload remains, then a transfer to the alternate AC source is to be completed.

5. **Backfeed Protection**

   As required by UL1778 and CSA, the static transfer switch shall not backfeed 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 an internal automatic 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.

6. **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 monitor the bypass line to ensure a fast, in-phase transfer of the load to the UPS inverter. 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.

It shall be possible to control (Activate/ Deactivate) Eco Mode via a programmed input contact.

The UPS control shall have the capability to suspend Eco Mode operation when certain conditions exist. A log of the times Eco Mode has been suspended shall be generated and be accessible to the user.

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 touch screen liquid crystal display shall be used to enter setpoints for the battery test (duration and end voltage), display system information, metering information, a one-line diagram of the UPS and battery, active events, event history, startup instructions and transfer and shutdown screens.

No mechanical push buttons shall be used.

Access to the control and configuration functions shall be protected by a four-digit passcode. After the passcode is keyed in, the user shall be prompted for a confirmation. The passcode shall not be required to access informational screens.

2. **Logic**

UPS system logic and control programming shall be resident 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 ±1% of voltage, ±3% 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
- Load percentage of capacity
- Battery temperature, each battery string
- Battery state of charge

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.)
   - Backfeed Breaker
   - Maintenance Bypass Status

5. **Main Display Screen**

   The main display screen of the UPS shall be the default screen and shall provide the following information:

   - Operating in Eco-Mode
   - System Status
   - Warning Indicator
   - Fault Indicator
   - Bypass Input Voltage
   - Bypass Input Frequency
   - Input Voltage Line to Line
   - Input Frequency
   - Output Voltage, Line to Line
   - Output Current, Per Phase
   - Output Frequency
   - DC Source Voltage
   - DC Source Current

6. **Touchscreen Control Buttons**

   Buttons shall be provided to start and stop the inverter. A pop-up message requesting confirmation shall be displayed whenever a command is initiated that would change the status of the UPS.

   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 200 events, with the oldest events being overwritten first if the capacity is reached.

8. **Measures Menu**

   A “measures menu” shall provide access to the full set of measurements for each functional block (rectifier, bypass, DC-DC converter, batteries, inverter and load).

9. **Battery Status Indicator**

   A battery status indicator shall display DC alarm conditions, temperature, battery state of charge, the present battery voltage, total discharge time, status of last battery test and battery time remaining during discharge. A graphical representation of the battery voltage during the discharge shall be displayed. The graphical representation shall remain in the monitoring system memory until the next discharge occurs and shall be available for review of the battery performance.

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

   - Configure and manage manual battery test.
   - Modify test duration and minimum voltage
   - Start battery test
   - Monitor test status and progression
   - Stop battery test
   - Battery test status

10. **Alarms**

    The control panel shall report the system-level alarms listed below. An audible alarm shall be activated when any of the following alarms occurs. All alarms shall be displayed in text form.

Placement into service or test mode	Inverter Off warning
Maintenance Bypass switch closed	Inverter Off pending command
Fan life exceeded	Current limit
Synchronization system fault	kW protection
DIC Power-up	Inverter Off for shutdown command
System shutdown (DIC generated)	Bypass switch open
ID card missing	Bypass line power failure
Calibration started	Bypass wrong phase rotation
Input air high temperature	Bypass disabled for DC voltage low
Input air temp. out of range	Bypass overtemperature warning
SBS output switch open	Low battery time remaining
SBS Bypass switch closed	Battery end of discharge
Do not insert battery switch	High battery temperature
Line power switch open	Battery temp. out of range
SBS output switch closed	Temperature probe not responding
Inverter overtemperature warning	Battery autonomy test
DC undervoltage	High battery temperature
Overload warning	Battery temperature out of range

11. **Controls**

System-level control functions shall be:

- Start Inverter (and transfer to inverter)
- Stop Inverter (after transferring to bypass)
- Startup Screen
- Battery Test Setpoint Adjustment
- Configure Manual Battery Test
- Initiate Manual Battery Test
- Reset (Fault Cleared)
- System Settings (Time, Date, Language, LCD Brightness, Passcode)
- Audio Silence Command
- Alarm Reset Command

12. **Manual Procedures**

Load Transfers

Two touch-screen 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

1. 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 Capability

1. Remote Service Delivery

The UPS manufacturer shall provide remote monitoring capability with a user-supplied internet connection for remote diagnostic and monitoring of the UPS system to provide early warning of UPS and single module alarm conditions and out-of-tolerance conditions. This shall allow effective proactive maintenance and fast incident response. First year operation remote monitoring service shall be included.

2. Communication Cards

The UPS shall be equipped with one bay for an optional communication card.

- Optional SNMP Web card, providing SNMP, Telnet and Web-management capability, shall be available.
- Optional Dual Protocol card with choice of any two of the following protocols can be selected
  - SNMP
  - Vertiv™ Liebert® Modbus (over IP or RS-485)
  - BACnet
- Optional Card for connection to Vertiv™ Liebert® SiteScan™ system only.

3. Output Alarm Contacts

   Dry contact outputs shall be provided for:

   - Summary Alarm
   - Bypass Active
   - Low Battery
   - Operating on generator
   - AC Input Failure, and
   - Two selectable

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.
   - Start Battery Test—Manually initiate an automated battery test operation.
   - Stop Battery Test—Manually stop an automated battery test 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 UPS shall have a properly rated circuit breaker (600VDC) to isolate it from the base module. This breaker shall be in a separate NEMA-1 enclosure or in a matching battery cabinet. When open, there shall be no battery voltage in the UPS enclosure. The UPS shall be automatically disconnected from the battery by opening the breaker when the battery reaches the minimum discharge voltage level or when signaled by other control functions.

2.3.9 Optional Accessories

1. **AC Input Circuit Breaker**

   The rectifier shall have as an option an internal AC input circuit breaker. The circuit breaker shall be of the frame size and trip rating to supply full rated load and recharge the battery at the same time. The circuit breaker shall have an undervoltage release to open automatically if the control voltage is lost.

2. **Remote Alarm Panel**

   The remote alarm panel shall have LED alarm lights. An audible alarm shall sound upon any alarm condition. The surface-mounted NEMA 1 enclosed panel shall indicate:

   - Load on UPS
   - Load on Bypass
   - Battery Discharging
   - Low Battery Warning
   - Overload
   - Audible Alarm with Reset

3. **Load Bus Sync Controller**

   The Load Bus Sync Controller shall enable two independent single-module UPS units to stay in sync when operating on battery or unsynchronized input sources. The LBS Controller shall determine the primary/secondary relationship between UPS units. An LBS Controller shall be installed within each single-module UPS.

4. **Dual Protocol Web Card**

   A Web card shall be provided to deliver SNMP, SMS Text Messaging, Telnet and Web-based management capability for enhanced communication as well as a choice of any two of the following protocols:

   - SNMP
   - Vertiv™ Liebert® Modbus over IP or RS-485
   - BACnet

5. **Seismic Anchorage Kits**

   Seismic anchorage kits shall be provided with the UPS unit, and if included the optional battery cabinet, for use in seismic restraint as required for IBC 2012 certification.

6. **Scalable Output Capacity**

   UPS rated output capacity of certain models shall be scalable by means of a software upgrade available for purchase from the manufacturer which will require no hardware modifications to the UPS. Models shall be available in capacity ranges of 225, 250, 400 and 500kVA.

   - 225kVA and 250kVA models shall be scalable to 300kVA.
   - 400kVA model shall be scalable from 400kVA to 500kVA to 600kVA.
   - 500kVA model shall be scalable to 600kVA.

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 or
- Vycon Flywheel Energy Storage System.

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

Visual Inspection

1. Inspect equipment for signs of damage.
2. Verify installation per drawings supplied with installation manuals or submittal package.
3. Inspect cabinets for foreign objects.
4. 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.
5. Inspect electrolyte level in cells (flooded cells only).
6. Inspect all cell cases.
7. Inspect each cell for proper polarity.
8. Verify that all printed circuit boards are configured properly.

Mechanical Inspection

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

Electrical Inspection

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

4.2 UNIT Startup

1. Energize control power.
2. Perform control/logic checks and adjust to meet Vertiv specifications.
3. Verify DC float and equalize voltage levels.
4. Verify DC voltage clamp and overvoltage shutdown levels.
5. Verify battery discharge, low battery warning and low battery shutdown levels.
6. Verify fuse monitor alarms and system shutdown.
7. Verify inverter voltages and regulation circuits.
8. Verify inverter/bypass sync circuits and set overlap time.
9. Perform manual transfers and returns.
10. Simulate utility outage at no load.
11. Verify proper recharge.

4.3 Manufacturer's Field Service

4.3.1 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.

4.3.2 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.

4.3.3 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.

4.3.4 Maintenance Contracts

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