

Schneider Electric
SYMMETRA PX 250/500 kW [Parallel]
[Single UPS (100 kW to 500 kW)] [Parallel UPSs (100 kW to 2 MW)]
Uninterruptible Power Supply

THIS GUIDE SPECIFICATION IS WRITTEN IN ACCORDANCE WITH THE CONSTRUCTION SPECIFICATIONS INSTITUTE (CSI) MASTERFORMAT. THIS SECTION MUST BE CAREFULLY REVIEWED AND EDITED BY THE ARCHITECT OR THE ENGINEER TO MEET THE REQUIREMENTS OF THE PROJECT. COORDINATE THIS SECTION WITH OTHER SPECIFICATION SECTIONS IN THE PROJECT MANUAL AND WITH THE DRAWINGS. WHERE REFERENCE IS MADE THROUGHOUT THIS SECTION TO "PROVIDE", "INSTALL", "SUBMIT", ETC., IT SHALL MEAN THAT THE CONTRACTOR, SUBCONTRACTOR, OR CONTRACTOR OF LOWER TIER SHALL "PROVIDE", "INSTALL", "SUBMIT", ETC., UNLESS OTHERWISE INDICATED. THIS SECTION IS WRITTEN TO INCLUDE THE 2004 MASTERFORMAT AND THE 1995 MASTERFORMAT VERSIONS. WHERE APPLICABLE, THESE ITEMS ARE BRACKETED AND, IN EACH CASE, UNLESS OTHERWISE INDICATED, THE FIRST CHOICE APPLIES TO THE 2004 MASTERFORMAT AND THE SECOND CHOICE APPLIES TO THE 1995 MASTERFORMAT.

SECTION [26 33 53] [16611]

STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 SUMMARY

- A. **Scope:** Provide design and engineering, labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for a static uninterruptible power supply (UPS) as required for the complete performance of the work, and as shown on the Drawings and as herein specified.
- B. **Section Includes:** The work specified in this Section includes, but shall not be limited to, a continuous duty, three-phase, solid state, on-line double conversion static UPS.
1. The UPS shall utilize a rack-mounted N+1 redundant, scalable array architecture. The system power train shall be comprised of 25 kVA/25 kW power modules and shall be capable of being configured for N+X redundant operation at the rated system load.

[In parallel systems operating at a load where the system has N+1 system-level redundancy or greater, the parallel configuration shall facilitate the replacement of individual UPSs while the system remains in normal operation, without the requirement to transfer to bypass.]

2. Each swappable/trained-user replaceable 25 kVA/25 kW power module shall contain a fully rated, power factor corrected input rectifier/boost converter hereafter referred to as the PFC input stage, a fully rated output inverter, battery charging circuit and field replaceable fans. Power module fans shall be variable speed controlled and capable of maintaining the system in the event of a single fan failure. The system shall also be comprised of a swappable continuous duty bypass static switch module, redundant control modules, redundant logic power supplies, and touch screen user interface/display. Swappable/trained-user-replaceable battery modules shall be available as an option.
3. All of the above system components shall be housed in standard NetShelter SX Racks with one of the following dimensions:
 - a. 600 mm wide by 1070 mm deep by 2000 mm high (I/O Frame or Power Frame)
 - b. 750 mm wide by 1070 mm deep by 2000 mm high (Battery Frame)
 - c. 300 mm wide by 1070 mm deep by 2000 mm high (optional Battery Side Car or optional Bottom Feed Frame)
 - d. 1000 mm wide by 1070 mm deep by 2000 mm high (optional I/O Frame with Maintenance Bypass with Distribution). [Maintenance Bypass Panels for parallel

systems will be customized and will have custom dimensions based on the configuration.]

The racks shall require no rear access for maintenance.

4. In addition, this Section describes the performance, functionality, and design of the optional maintenance bypass cabinet with output distribution, hereafter referred to as the maintenance bypass and the battery system. The maintenance bypass shall not be included or supported by UPSs in parallel configurations.
5. The UPS and associated equipment shall operate in conjunction with a primary power supply and an output distribution system to provide quality uninterrupted power for mission critical, electronic equipment load.
6. All programming and miscellaneous components for a fully operational system as described in this Section shall be available as part of the UPS.

1.2 REFERENCES

- A. **General:** The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
- B. **Institute of Electrical and Electronics Engineers, Inc. (IEEE):**
 1. ANSI/IEEE 519, "Guide for Harmonic Control and Reactive Compensation of Static Power Converters" (copyrighted by IEEE, ANSI approved).
- C. **International Organization for Standardization (ISO):**
 1. ISO 9001, "Quality Management Systems - Requirements."
 2. ISO 14001, "Environmental Management Systems - Requirements with Guidance for Use."

1.3 [SINGLE][PARALLEL] SYSTEM DESCRIPTION

- A. **Design Requirements:**

INSERT APPLICABLE VALUES IN SUBPARAGRAPHS BELOW.

 1. The UPS shall be sized for [_____] kVA and [_____] kW load.
 2. [The parallel system shall be comprised of [_____] UPSs for N+ [_____] system-level redundancy.]
 3. [The parallel system shall be sized for [_____] kVA and [_____] kW load.]
 4. The UPS battery shall be sized for [_____] kVA at a power factor of [_____] for [_____] minutes.
- B. **System Characteristics:**
 1. **System Capacity:** The system shall be rated for full kW output in the following frame sizes:
 - a. 250 kVA/kW—can be configured with up to ten (10) 25 kW power modules for 250 kW N+0 or 225 kW N+1 module-level redundancy.
 - b. 500 kVA/kW—can be configured with up to twenty (20) 25 kW modules for 500 kW N+0 or 475 kW N+1 module-level redundancy
 - c. [2MW—can be configured with 25kW power modules for up to 2MW N+0 redundancy or up to 1.5MW N+1 system-level redundancy]
 2. **Input:** The system input shall be configurable as either single or dual mains derived from a three phase wye source. Standard cable entry shall be through the top. Bottom cable entry shall also be facilitated. Depending on the specific configuration, the use of the bottom feed enclosure may be required. An option shall be available to facilitate the connection of NEMA 2 compression lugs for main input, bypass input, DC input, and output cable connections.
 - a. **AC Input Nominal Voltage:** System voltage shall support 3-phase + neutral + ground or 3-phase + ground in a dual or single mains configuration and be selectable at the front panel by service personnel with the following options:

- 1) 380 volts, 400 volts, 415 volts, and 480 volts.
 - b. **AC Input Voltage Window:**
 - 1) ± 15 percent for full performance (340 to 460 volts at 400 volts, 408 volts to 552 volts at 480 volts).
 - 2) -50 percent for reduced load (200 volts at 400 volts, 240 volts at 480 volts).
 - c. **Short Circuit Withstand Rating:**
 - 1) **UPS:** 65,000 Symmetrical Amperes
 - 2) **Optional Maintenance Bypass with Distribution Panel:** 50,000 Symmetrical Amperes or lowest rated subfeed circuit breaker
 - 3) **Custom Switchgear:** 65,000 Symmetrical Amperes or as specified
 - 4) **Lowest Rated Subfeed Circuit Breaker (60-100A) for Maintenance Bypass:** 22,000 Symmetrical Amperes
 - 5) **Lowest Rated Subfeed Circuit Breaker (125-400A) for Maintenance Bypass:** 25,000 Symmetrical Amperes
 - 6) **Custom Subfeed Circuit Breakers for Maintenance Bypass:** Subfeed circuit breakers with a short circuit withstand rating greater than 22,000 Symmetrical Amperes or 25,000 Symmetrical Amperes shall be available as a custom option.
 - d. **Maximum Frequency Range:** 40 to 70 hertz.
 - 1) Frequency shall be synchronized to bypass input when available over the standard range of 57 to 63 hertz. Optional frequency tolerance range shall be configurable from 0.5 percent to 8 percent from front panel. Default shall be $\pm 1\%$ ($\pm 0.6\text{Hz}$ at 60Hz).
 - e. **Input Power Factor:**
 - 1) Greater than 0.995 with load at 100 percent.
 - 2) Greater than 0.99 with loads above 50 percent.
 - 3) Greater than 0.97 with loads above 25 percent.
 - f. **Input Current in Normal Operation:**
 - 1) As a percentage of output current, with no charging, will be limited to a maximum of 105 percent of system capacity
 - g. **Input Current Distortion with No Additional Filters:**
 - 1) Less than 5 percent.
 - h. **Soft-Start:**
 - 1) Shall be linear from 0 percent to 100 percent input current and shall not exhibit inrush. This shall take place over an owner-selectable 1 second to 40 second time period with a factory default of 15 seconds.
 - i. Symmetra PX 250/500 kW 480 V is OSHPD pre-approved when the seismic anchoring kits are installed
3. **UPS Output:**
- a. **AC Output Nominal Output:** System voltage shall support 3-phases + neutral + ground or 3-phases + ground be selectable at the graphical user interface by service personnel with the following options:
 - 1) 380 volts, 400 volts, 415 volts, and 480 volts.
 - b. **AC Output Voltage Distortion:** Less than 2 percent at 100 percent linear load, less than 3 percent for SMPS load as defined by IEC 62040-3.
 - c. **AC Output Voltage Regulation:** ± 1 percent for 100 percent linear or non-linear load.
 - d. **Voltage Transient Response:** ± 5 percent maximum RMS change in a half cycle at load step 0 percent to 100 percent or 100 percent to 0 percent.
 - e. **Voltage Transient Recovery:** Within less than 50 milliseconds.
 - f. **Output Voltage Harmonic Distortion:** Less than 2 percent from 0 to 100% load. Less than 3 percent full non-linear load according to IEC/EN62040-3.
 - g. **Overload Rating:**
 - 1) **Normal Operation:**
 - a) 150 percent for 60 seconds before transfer to bypass.
 - b) 125 percent for 10 minutes before transfer to bypass.
 - 2) **Battery Operation:** 125 percent for 30 seconds (up to 10 minutes with fully configured battery solution)
 - 3) **Bypass Operation:**
 - a) 125 percent continuous at 480 volts.
 - b) 110 percent continuous at 400 volts
 - c) 1000 percent for 100 milliseconds.
 - h. **System AC-AC Efficiency:**

- 1) Normal operation greater than 96 percent at 40 percent to 100 percent load.
- 2) Battery operation greater than 95 percent at 40 percent to 100 percent load.
- i. **Output Power Factor Rating:** 0.5 leading to 0.5 lagging without any derating.
4. **Charge current:**
 - a. 20% of charging capacity when the load is less than 90%
 - b. 10% of charging capacity with 100% load
5. **Parallel cabling:**
 - a. The standard cable distance shall be 25 m (81.3 ft)
 - b. Custom cables of other lengths shall be accommodated.
 - c. The maximum cable distance shall be 75 m (244 ft) across all UPSs in the installation.
6. **Regulatory compliance:** The UPS shall comply with the following standards:
 - a. **Underwriters Laboratories, Inc. (UL):**
 - 1) UL 891, "Standard for Dead-Front Switchboards" (copyrighted by UL, ANSI approved).
 - 2) UL 1558, "Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear."
 - 3) UL 1778, "Standard for Uninterruptible Power Supply Equipment" (copyrighted by UL, ANSI approved).
 - 4) UL 60950, "Standard for Information Technology Equipment."
 - 5) CSA C22.2 No.107.3-05 Uninterruptible Power Systems
 - b. **International Electrotechnical Commission (IEC):**
 - 1) IEC 61000-4-2, "Electromagnetic Compatibility - Testing and Measurement Techniques; Electrostatic Discharge Immunity Test."
 - 2) IEC 61000-4-3, "Electromagnetic Compatibility - Testing and Measurement Techniques; Radiated, Radio Frequency, Electromagnetic Field Immunity Test."
 - 3) IEC 61000-4-4, "Electromagnetic Compatibility - Testing and Measurement Techniques; Electrical Fast Transient/Burst Immunity Test."
 - 4) IEC 61000-4-5, "Electromagnetic Compatibility - Testing and Measurement Techniques; Surge Immunity Test."
 - 5) IEC 62040-2, "Uninterruptible Power Systems - Electromagnetic Compatibility (EMC) Requirements,"
 - 6) IEC 62040-3, "Uninterruptible Power Systems - Method of Specifying the Performance and Test Requirements."

1.4 SUBMITTALS

- A. **Product Data:** Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications. Product data shall include, but shall not be limited to, the following:
 1. As bid system bill of materials.
 2. Product catalog sheets or equipment brochures.
 3. Product guide specifications.
- B. **Shop Drawings:** Submit shop drawings for each product and accessory required. Include information not fully detailed in manufacturer's standard product data, including, but not limited to, the following:
 1. Installation information, including, but not limited to, weights and dimensions.
 2. Information about terminal locations for power and control connections.
 3. Drawings for requested optional accessories.
- C. **Wiring Diagrams:** Submit wiring diagrams detailing power, signal, and control systems, clearly differentiating between manufacturer-installed wiring and field-installed wiring, and between components provided by the manufacturer and those provided by others.
 1. Submit system single-line operation diagram.
- D. **Operation and Maintenance Data:** Submit operation and maintenance data to include in operation and maintenance manuals, including, but not limited to, safe and correct operation of UPS functions.
 1. Submit an installation manual, which shall include, but shall not be limited to, instructions for storage, handling, examination, preparation, installation, and start-up of UPS.

2. Submit an operation and maintenance manual, which shall include, but shall not be limited to, operating instructions.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. **Manufacturer Qualifications:** Manufacturer shall be a firm engaged in the manufacture of solid state UPS of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of 20 years.
 - a. The manufacturer shall be ISO 9001 certified and shall be designed to internationally accepted standards.
2. **Installer Qualifications:** Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing solid state UPS similar in type and scope to that required for this Project.

B. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.

1. Where applicable, the UPS shall also be designed in accordance with publications from the following organizations and committees:
 - a. National Fire Protection Association (NFPA).
 - b. National Electrical Manufacturers Association (NEMA).
 - c. Occupational Safety and Health Administration (OSHA).
 - d. Institute of Electrical and Electronics Engineers, Inc. (IEEE); ANSI/IEEE 519.
 - e. ISO 9001
 - f. ISO 14001
 - g. IEC 61000-4-2.
 - 1) **Performance:** Minimum Level 3, Criterion A.
 - h. IEC 61000-4-3.
 - 1) **Performance:** Minimum Level 2, Criterion A.
 - i. IEC 61000-4-4.
 - 1) **Performance:** Minimum Level 2, Criterion A.
 - j. IEC 61000-4-5.
 - 1) **Performance:** Minimum Level 3, Criterion A.
 - k. IEC 62040-2, UL1778 (CUL), UL60950-1
 - l. EN50091-2 / IEC62040 (Class A), FCC15A
 - m. VFI-SS-111 performance level compliance (Voltage and Frequency Independent).
 - n. VFI-SS-112 protection class (Voltage and Frequency Independent).

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and lot number, if any.
- B. The customer shall store materials in their original, undamaged packages and containers, inside a well ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.7 PROJECT CONDITIONS

- A. **Environmental Requirements:** Do not install solid state UPS until space is enclosed and weatherproof, wet work in space is completed and nominally dry, work above ceilings is complete, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated for final occupancy.

1. **Temperature:**
 - a. **Storage Ambient Temperature:** -15 °C to 40 °C (5 °F to 104 °F)
 - b. **Storage Ambient Temperature without batteries:** -30 °C to 70 °C (-22 °F to 158 °F) without batteries).
 - c. **Operating Ambient Temperature:** 32 °F to 104 °F (0 °C to 40 °C)
 - d. **Ideal Operating Ambient Temperature (for most battery types):** 25 °C (77 °F)

2. **Humidity:**
 - a. **Relative Humidity:** 0 percent to 95 percent.
 - b. **Operating Relative Humidity:** 0 percent to 95 percent non-condensing.
 - c. **Altitude:** Maximum installation with no derating of the UPS output shall be 3280 feet (1000 m) above sea level. The UPS capacity shall be derated for altitude as follows:
 - 1) 4921 feet (1500 m), 95 percent load.
 - 2) 6562 feet (2000 m), 91 percent load.
 - 3) 8202 feet (2500 m), 86 percent load.
 - 4) 9843 feet (3000 m), 82 percent load.
3. **Audible Noise (As Measured 3 Feet [914 mm] From Surface):**
 - a. **At 480 Volt Operation (at 25 °C [77 °F]):**
 - 1) 54 dBA at 100 percent load.
 - 2) 45 dBA at 70 percent load.
 - b. **At 400 Volt Operation (at 25 °C [77 °F]):**
 - 1) 60 dBA at 100 percent load.
 - 2) 49 dBA at 70 percent load.

1.8 WARRANTY

- A. **Special Warranty:** The Contractor shall warrant the work of this Section to be in accordance with the Contract Documents and free from faults and defects in materials and workmanship for period indicated below. This special warranty shall extend the one year period of limitations contained in the General Conditions. The special warranty shall be countersigned by the Installer and the manufacturer.
 1. **UPS Module:** The UPS shall be covered by a full parts and labor warranty from the manufacturer for a period of 12 months from date of installation or acceptance by the Owner or 18 months from date of shipment from the manufacturer, whichever occurs first.
- B. **Additional Owner Rights:** The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

1.9 MAINTENANCE

- A. A complete offering of preventative and full service maintenance contracts for the UPS system and the battery system shall be available from the manufacturer. Contract work shall be performed by factory trained service personnel.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Basis of Design:** Product specified is "Symmetra PX 250/500 kW" as manufactured by Schneider Electric. Items specified are to establish a standard of quality for design, function, materials, and appearance. Equivalent products by other manufacturers are acceptable. The Architect/Engineer will be the sole judge of the basis of what is equivalent.

2.2 MODES OF OPERATION

- A. **Normal:** The PFC input stage and output inverter shall operate in an on-line manner to continuously regulate power to the critical load. The input and output converters shall be capable of full battery recharge while simultaneously providing regulated power to the load for all line and load conditions within the range of the UPS specifications.
- B. **Battery:** Upon failure of the AC input source, the critical load shall continue being supplied by the output inverter, which shall derive its power from the battery system. There shall be no interruption in power to the critical load during both transfers to battery operation and retransfers from battery to normal operation. Upon restoration of utility power to the UPS input, the UPS shall recharge the battery.
- C. **Static Bypass:** The static bypass shall be used to provide controller transfer of critical load from the inverter output to the bypass source. This transfer, along with its retransfer, shall take place with no power interruption to the critical load. In the event of a UPS output fault or significant output overload emergency, this transfer shall be an automatic function. Manual

transfer to static bypass (called “requested bypass”) shall be available in order to facilitate a controlled transfer to maintenance bypass. [For parallel systems, the static bypass switches shall be installed in parallel.]

- D. **Maintenance Bypass:** The system shall be equipped with an optional integrated, bus connected external maintenance bypass to electrically isolate the UPS during routine maintenance and service of the UPS. The maintenance bypass shall allow for the complete electrical isolation of the UPS. An option for an external make-before-break maintenance bypass panel shall be available.
- E. **Parallel Operation:** The system shall have the option to install up to four (4) UPSs in parallel configuration for redundancy or capacity.
1. The parallel UPS system shall be of the same design, voltage, and frequency. UPS modules of different size ratings shall be permitted to be paralleled together for purposes of increased capacity or UPS module redundancy. The UPSs in the parallel configuration shall not be required to have the same load capacity rating.
 2. **Parallel Capacity:** With N+0 system-level redundancy, up to 2MW of load can be supported by the system.
 3. **Parallel Redundancy:** With N+1 system-level redundancy, up to 1.5MW of load can be supported by the system, and only the UPS being replaced must be isolated from the source (bypass operation is not required for the entire system during the UPS replacement procedure).
 4. **Output control:** A load sharing circuit shall be incorporated into the parallel control circuits to ensure that under no-load conditions, no circulating current exists between modules. This feature also allows each UPS to share equal amounts of the total critical load bus. The output voltage, output frequency, output phase angle, and output impedance of each module shall operate in uniformity to ensure correct load sharing. This control function shall not require any additional footprint and shall be an integral function of each UPS. The static bypass switches shall be connected in parallel.
 5. **Parallel System Controls:** To avoid single points of failure, the UPS system shall have no single dedicated control system designed to control the operation of the parallel UPS system. Control of and direction of parallel UPSs shall take place via a master/slave relationship, where the first UPS to receive logic power asserts itself as a master. In the event of a master failure, a slave UPS shall take the role of master and assume the responsibility of the previous master UPS. Regardless of which UPS is master or slave, user changes to the system status, such as request for bypass, can be done from any UPS connected to the bus and all UPS on the bus shall transfer in simultaneously.
 6. **Communication:** Communication between modules shall be connected so that the removal of any single cable shall not jeopardize the integrity of the parallel communication system. Load sharing communications shall be galvanically isolated for purposes of fault tolerance between UPS modules. A UPS module's influence over load sharing shall be inhibited in any mode where the UPS inverter is not supporting its output bus. Transfers to and from bypass can be initiated from any online UPS in the system.
 7. **Display:** Each UPS multi-color LCD touch screen user interface shall be capable of using an active touch screen mimic bus to show the quantity of UPS(s) connected to the critical bus, as well as the general status of each UPS, such as circuit breaker status information. Any touch screen display shall support the configuration of the [entire parallel] system and shall provide event and alarm data for all UPSs in the parallel configuration. A Virtual Display Application shall be available for download to the customer's computer and shall support remote monitoring of a complete system with up to 4 UPSs in parallel.
 8. **Battery runtime:** Each UPS must have its own battery solution. The battery solution for the entire system can be a combination of standard and third-party batteries, but each UPS must use only one battery solution – either standard or third-party batteries.
 9. **Switchgear:** A custom switchgear option shall be required for parallel operation.
- F. **External Sync:** Synchronize the output of the UPS with any other independent source for use with downstream static transfer switches. The synchronization at the UPS is controlled from an input on the I/O relay board and can be controlled by a programmable logic controller. The

source input is either connected to a terminal in the maintenance bypass with distribution for a UPS with maintenance bypass or to a terminal in the external switchgear controller for a UPS without maintenance bypass. (Depending on the desired configuration, additional PLC hardware and programming may be required and shall be offered separately by Schneider Electric.)

- G. **MegaTie:** The UPS or block of UPSs may have the ability to transfer the load between them without active load sharing. The Mega Tie mode will be active for 60 seconds after it has been requested from a digital input on the relay board. The user has 60 seconds to transfer his load from one unit to another. After the 60 seconds, the UPS will automatically transfer back to normal operation. (Depending on the desired configuration, additional PLC hardware and programming may be required and shall be offered separately by Schneider Electric.)
- H. **EcoMode:** In bypass operation, an even higher operating efficiency may be achieved without sacrificing protection when there are good power conditions. Depending on configuration, efficiency can exceed 99%. The load remains in bypass mode until the input voltage exceeds tolerance levels, and then enters full protection mode. UPS performance Class B cannot be guaranteed during short circuit error scenarios and other conditions. This setting is disabled by default and can be configured using the touch screen display.

2.3 PFC INPUT STAGE

- A. **General:** The PFC input stage converters of the system shall be housed within the removable power modules, and the IGBT converters shall constantly control the power imported from the mains input of the system, to provide the necessary UPS power for precise regulation of the DC bus voltage, battery charging, and main inverter regulated output power. These power modules shall be connected in parallel within the UPS frame.
- B. **Input Current Total Harmonic Distortion:** The input current THDI shall be held to less than 5 percent at system load greater than 50 percent while providing conditioned power to the critical load bus, and charging the batteries under steady-state operating conditions. This shall be true while supporting both a linear or non-linear load. This shall be accomplished without the requirement for additional or optional filters, magnetic devices, or other components.
- C. **Soft-Start Operation:** As a standard feature, the UPS shall contain soft-start functionality, capable of limiting the input current from 0 percent to 100 percent of the nominal input over a default 10 second period, when returning to the AC utility source from battery operation. The change in current over the change in time shall take place in a linear manner throughout the entire operation.
- D. **Magnetization Inrush Current:** The UPS shall exhibit zero inrush current. The default soft-start is 15 seconds.
- E. **Input Current Limit:**
 - 1. The PFC input stage shall control and limit the input current draw from utility to 124 percent of the UPS output. During conditions where input current limit is active, the UPS shall be able to support 100 percent load at -15% utility power and no charge power.
 - 2. In cases where the source voltage to the UPS is nominal and the applied UPS load is equal to or less than 100 percent of UPS capacity, input current shall not exceed 116 percent of UPS output current, while providing full battery recharge power and importing necessary power to account for system losses.
- F. **Redundancy:** The UPS shall be capable of being configured with redundant PFC input stages, each with semiconductor fusing, and logic-controlled contactors to isolate a failed module from the input bus.
- G. **Charging:**
 - 1. The battery charging shall keep the DC bus float voltage of ± 327 volts, ± 1 percent.
 - 2. The battery charging circuit shall contain a temperature compensation circuit, which shall regulate the battery charging to optimize battery life.
 - 3. The battery charging circuit shall remain active when in static bypass and in normal operation.

4. The UPS shall be capable of reducing the battery charging current under low input voltage conditions as long as utility power for the PFC is being provided.
5. Battery charge shall be limited to 10 percent of the system capacity by default (or optionally, 20% with reduced load).
6. The battery charging circuit will support boost, auto boost and equalization functions
7. An input connection will be provided that will allow the user to inhibit boost charging.
8. The UPS shall be capable of reducing the battery charging current down to zero based on user defined input.

H. **Backfeed Protection:** The above mentioned logic-controlled contactor shall also provide the backfeed protection required by UL 1778.

2.4 OUTPUT INVERTER

- A. **General:** The UPS output inverter shall constantly develop the UPS output voltage waveform by converting the DC bus voltage to AC voltage through a set of IGBT driven bi-directional power converters. In both normal operation and battery operation, the output inverters shall create an output voltage independent of the mains input voltage. Input voltage anomalies such as brown-outs, spikes, surges, sags, and outages shall not affect the amplitude or sinusoidal nature of the output voltage sine wave of the inverters.
- B. **Overload Capability:** The output power converters shall be capable of 230 percent for short circuit clearing. Steady-state overload conditions of up to 150 percent of system capacity shall be sustained by the inverter for 60 seconds in normal operation. Steady-state overload conditions of up to 125 percent of system capacity shall be sustained by the inverter for 10 minutes in normal operation. Overloads persisting past the outlined time limitation the critical load shall be switched to the automatic static bypass output of the UPS.
- C. **Output Contactor:** The output inverter shall be provided with an output mechanical contactor to provide physical isolation of the inverter from the critical bus. With this feature a failed inverter shall be isolated from the critical bus.
- D. **Battery Protection:** The inverter shall be provided with monitoring and control circuits to limit the level of discharge on the battery system.
- E. **Redundancy:** The UPS shall be capable of being configured with redundant output inverters, each with semiconductor fusing, and logic-controlled contactors to remove a failed component from the input, DC, and output critical bus.

2.5 STATIC BYPASS

- A. **General:** As part of the UPS, a system static bypass module shall be provided. The system static bypass shall be swappable and provide no break transfer of the critical load from the inverter output to the static bypass input source during times where maintenance is required, or the inverter cannot support the critical bus. Such times may be due to prolonged or severe overloads, or UPS failure. The UPS and static bypass module shall constantly monitor the auxiliary contacts of their respective circuit breakers, as well as the bypass source voltage, and inhibit potentially unsuccessful transfers to static bypass from taking place.
- B. **Design:** The design of the static switch power path shall consist of silicon-controlled rectifiers (SCR) with a continuous duty rating of 125 percent of the UPS output rating for 480 V systems and 110% for 400/415 V systems.
- C. **Automatic Transfers:** An automatic transfer of load to static bypass shall take place whenever the load on the critical bus exceeds the overload rating of the UPS. Automatic transfers of the critical load from static bypass back to normal operation shall take place when the overload condition is removed from the critical output bus of the system. Automatic transfers of load to static bypass shall also take place if for any reason the UPS cannot support the critical bus.
- D. **Manual Transfers:** Manually initiated transfers to and from static bypass shall be initiated through the UPS graphical user interface. [For parallel configurations, transfers to and from bypass can be initiated from any online UPS in the system.]

- E. **Overloads:** For 480V systems, the static bypass shall be rated and capable of handling overloads equal to or less than 125 percent of the rated system output continuously. For 400/415V systems, the static bypass shall be rated and capable of handling overloads equal to or less than 110 percent of the rated system output continuously. For instantaneous overloads caused by inrush current from magnetic devices, or short circuit conditions, the static bypass shall be capable of sustaining overloads of 1000 percent of system capacity for periods of up to 100 milliseconds.
- F. **Modular:** The static bypass switch shall be of a modular design.
- G. **System Protection:** As a requirement of UL 1778, backfeed protection in the static bypass circuit shall also be incorporated in the system design. To achieve backfeed protection, a mechanical contactor in series with the bypass SCR(s) shall be controlled by the UPS/static switch, to open immediately upon sensing a condition where backfeeding of the static switch by any source connected to the critical output bus of the system is occurring. One such condition could be a result of a shorted SCR.
- H. **Static Switch:** For parallel systems, static switch design shall be distributed/integral type. External static switch cabinets shall not be necessary.

2.6 DISPLAY AND CONTROLS

- A. **Control Logic:** The UPS shall be controlled by two fully redundant, owner-replaceable and swappable intelligence modules (IM). These modules shall have separate, optically isolated, communication paths to the power and static switch modules. Logic power for the control modules shall be derived from redundant power supplies, each having a separate AC and DC input and output. The communication of the control modules shall be of controller area network (CAN Bus) and EIA485. All control functions such as start-up, transfer to bypass, and all parameter changes shall be accessible from the touch screen user interface. Operations such as start-up will have step by step instructions from the user interface to ensure correct sequencing of operations. To further minimize user error, the touch screen shall highlight, in green, all functions that have been completed. The current step in the process shall also be outlined to ensure easy operation. Each UPS system shall have one such user interface.
- B. **Graphical User Interface:** A microprocessor-controlled user interface/display unit shall be located on the front of the system. The display shall consist of a 10.4 inch (264 mm) multicolor graphical display with 800 x 600 resolution. The display shall be localized into the following languages:
 1. Brazilian Portuguese
 2. Chinese
 3. French
 4. German
 5. Korean
 6. Russian
 7. Spanish
- C. **Virtual Display:** Download the display interface to your laptop or personal computer and monitor a complete system with up to 4 UPSs in parallel. Alarms and events are linked directly to the specific location shown in a picture of the actual customer setup. The interface matches the touch screen display interface and supports the configuration of the following parameters:
 1. Battery Test schedule settings and request of battery test
 2. Alarm threshold settings
 3. NMC settings
 4. System settings - names, date and time
 5. Predictive Maintenance settings of door filter
- D. **Metered Data:** The following data shall be available on the graphical user interface/display:
 1. Input/output voltages, currents, frequencies.
 2. Breaker and switch status.
 3. Battery status.

4. Event log.
 5. Energy measurements.
- E. **Event Log:** The display unit shall allow the Owner to display a time and date stamped log. The event log shall be capable of holding 1500 entries. The default event log size shall be 400 entries.
- F. **Alarms:** The display unit shall allow the Owner to display a log of active alarms. The following minimum set of alarm conditions shall be available:
1. Input frequency fault.
 2. Bypass voltage error, high voltage.
 3. MIM not present.
 4. RIM not present.
 5. Battery module removed from the system.
 6. Battery string disconnected.
 7. Power module removed from the system.
 8. Power module is disabled.
 9. Battery breaker open.
 10. Power module redundancy obtained.
 11. Battery condition is poor.
 12. Battery condition is weak.
 13. RIM in control.
 14. Batteries are discharging.
 15. Overload on UPS.
 16. Overload on system.
 17. Input voltage error, high voltage.
 18. Input voltage error, low voltage.
 19. Battery temperature high.
 20. Power module fan fault.
 21. Battery is below minimum acceptable runtime.
 22. Battery module fuse cleared or weak battery.
 23. Battery module type support error.
 24. Power module error, module has critical error.
 25. Power module warning, module is not working properly.
 26. MIM heartbeat signal error.
 27. RIM heartbeat signal error.
 28. Power module redundancy lost.
 29. Battery is below minimum acceptable runtime.
 30. Load on UPS is above warning level.
 31. Load on subfeed is above critical level.
 32. Load on subfeed is above warning level.
 33. Load on UPS is below warning level.
 34. Battery is above minimum acceptable runtime.
 35. Bypass input frequency fault.
 36. Bypass voltage error, high voltage.
 37. Bypass voltage error, low voltage.
 38. UPS operation mode - Forced Bypass.
 39. Load on UPS is above warning level.
 40. UPS operation mode - Forced Bypass.
 41. System locked in bypass operation.
 42. Breaker Q1 open.
 43. Breaker Q2 open.
 44. Breaker Q3 closed.
 45. Breaker Q4 open.
 46. Breaker Q5 open.
 47. Battery voltage error - voltage above warning level.
 48. Battery voltage error - voltage above shutdown level.
 49. Battery voltage error - voltage below shutdown level.
 50. Battery voltage error - voltage below warning level.
 51. Door in MBwD enclosure open.
 52. Door in maintenance bypass panel enclosure open.
 53. Parallel unit redundancy lost.

54. MegaTie mode is active.

- G. **Controls:** The following controls or programming functions shall be accomplished by the use of the user interface/display unit. The touch screen display shall facilitate these operations:
1. Silence audible alarm.
 2. Display or set the date and time.
 3. Enable or disable the automatic restart feature.
 4. Transfer critical load to and from static bypass.
 5. Test battery condition on demand.
 6. Set intervals for automatic battery tests.
 7. Adjust set points for different alarms.
 8. Adjustable ramp-in times from 1 to 40 seconds.
 9. Potential free (dry) contacts.
- H. **Potential Free Contacts or Dry Contacts:** The following potential free contacts shall be available on the relay interface board:
1. Normal operation.
 2. Battery operation.
 3. Bypass operation.
 4. Common fault.
 5. Low battery.
 6. UPS off.
- I. **Communication Interface Board:** A communication interface board shall provide the following communication ports which shall be able to be used simultaneously:
1. Ethernet.
 2. Ethernet interface port for a remote display.
 3. Modbus RS485
- J. **Emergency power off (EPO)** (Note: The EPO pushbutton shall include a protective cover to prevent unintentional operation).

2.7 BATTERY

- A. The UPS battery shall support an optional battery plant of modular construction made up of trained-user-replaceable, swappable, fused, battery modules. Each battery module shall be monitored for voltage and temperature for use by the UPS battery diagnostic. Battery charging current shall be temperature compensated. It should also be possible to cyclic charge the batteries with programmable charge and rest time.
- B. The battery jars housed within each removable battery module shall be of the valve regulated lead acid (VRLA) type.
- C. The UPS shall incorporate a battery management system to continuously monitor the status of each removable battery module. This system shall notify the Owner in the event a failed or weak battery module is found.
- D. The batteries shall have a design life of 5 to 8 years and a battery service life of 3 to 5 years. The battery casing shall be flame retardant type.
- E. The UPS shall incorporate a battery capacity test that will be capable of determining available runtimes.

2.8 ACCESSORIES

- A. **Battery Breaker Cabinet:** To facilitate third party battery configuration including wet cell batteries, a battery breaker cabinet in a line-up and match NetShelter enclosure shall be available. Each cabinet shall monitor breaker status and battery temperature. Each circuit breaker shall be equipped shunt trip mechanisms and 1A/1B auxiliary contacts. The battery breaker cabinet shall accommodate top or bottom entry for cables. The cell number count shall be adjustable from 138 to 150 from the user display with the default cell count set at 144.

B. Optional Maintenance Bypass:

1. The maintenance bypass shall provide power to the critical load bus from the bypass source, during times where maintenance or service of the UPS is required. The maintenance bypass shall provide a mechanical means of complete isolation of the UPS from the electrical wiring of the installation and shall be mounted to the systems I/O enclosure. As a minimum, the maintenance bypass shall contain the following features and accessories:

a. Subfeed circuit breakers of the appropriate size, withstand rating (see table), and trip rating for the system. Other breaker sizes and withstand ratings shall be available as custom options.

Breaker size	Interrupt rating
60-100A	22,000AIC
125-400A	25,000AIC

T-1, T-3, and T-5 breakers shall be supported.

b. Minimum 1A/1B auxiliary contacts for the purpose of relaying status information of each circuit breaker/switch actuator to the UPS and static bypass.

c. Plated copper bus bar (where applicable), braced for the appropriate withstand rating (50 kAIC rating) of the system.

d. A load test port (not breaker protected)

e. Field configurable such that the maintenance bypass can be located on the left or right side of the system Input / output cabinet

2. The following minimum options shall also be available for the maintenance bypass:

a. Mimic label with light indications for power flow.

3. The Maintenance bypass shall carry one of the following agency listings:

a. UL 891.

b. UL 1558.

c. UL 1778.

d. UL 60950.

C. Remote Batteries: The modular batteries shall have the capability to be located remote to the UPS. In such installations, an optional side car shall be used to connect the batteries by cables to the UPS. The battery side car shall accommodate top or bottom cable entry. The side car shall have overcurrent fuses to protect the cables. The fuse status shall be monitored by the UPS.

D. Bottom-Feed Enclosure: For installations greater than 250 kW, a bottom-feed enclosure shall provide the mechanical means necessary to support bottom feeds for specific system configurations.

E. Relay Board: Relay boards shall be provided for Owner connections to external alarms or to activate external Owner circuits.

F. Software and Connectivity:

1. **Network Adaptor:** The Network Management Card shall allow one or more network management systems (NMS) to monitor and manage the UPS in TCP/IP network environments. The management information base (MIB) shall be provided in DOS and UNIX "tar" formats. The SNMP interface adaptor shall be connected to the UPS via Ethernet Port.

2. **Unattended Shutdown:** The UPS, in conjunction with a network interface card, shall be capable of gracefully shutting down one or more operating systems when the UPS is operating from the battery.

G. Remote UPS Monitoring: The following methods of remote UPS monitoring shall be available:

1. **Web Monitoring:** Remote monitoring shall be available via a web browser such as Internet Explorer.

2. **Simple Network Management Protocol (SNMP):** Remote UPS monitoring shall be possible through a standard MIB II compliant platform.

H. **Software Compatibility:** The UPS manufacturer shall have available software to support graceful shutdown and remote monitoring with PowerChute Network Shutdown (PCNS) for the following operating system families:

1. Microsoft Windows
2. MAC OS X
3. Hyper-V
4. VMware
5. Linux
6. Unix

The full and updated supported OS compatibility chart can be found here:

<http://www.apc.com/whitepaper/?um=200>

PART 3 - EXECUTION

3.1 EXAMINATION

- A. **Verification of Conditions:** To ensure full warranty coverage, a Schneider Electric certified technician must perform the start-up service. Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Architect/Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 INSTALLATION

- A. **General:** Preparation and installation shall be in accordance with reviewed product data, final shop drawings, manufacturer's written recommendations, and as indicated on the Drawings.
- B. **Factory-Assisted Start-Up:** If a factory-assisted UPS start-up is requested, factory-trained service personnel shall perform the following inspections, test procedures, and on-site training:
1. **Visual Inspection:**
 - a. Inspect equipment for signs of damage.
 - b. Verify installation per manufacturer's instructions.
 - c. Inspect cabinets for foreign objects.
 - d. Inspect battery units.
 - e. Inspect power modules.
 2. **Mechanical Inspection:**
 - a. Check UPS and external maintenance bypass cabinet internal control wiring connections.
 - b. Check UPS and external maintenance bypass cabinet internal power wiring connections.
 - c. Check UPS and external maintenance bypass cabinet terminal screws, nuts, and/or spade lugs for tightness.
 3. **Electrical Inspection:**
 - a. Verify correct input and bypass voltage.
 - b. Verify correct phase rotation of mains connections.
 - c. Verify correct UPS control wiring and terminations.
 - d. Verify voltage of battery modules.
 - e. Verify neutral and ground conductors are properly landed.
 - f. Inspect external maintenance bypass switch for proper terminations and phasing.
 4. **Site Testing:**
 - a. Ensure proper system start-up.
 - b. Verify proper firmware control functions.
 - c. Verify proper firmware bypass operation.
 - d. Verify proper maintenance bypass switch operation.
 - e. Verify system set points.
 - f. Verify proper inverter operation and regulation circuits.
 - g. Simulate utility power failure.
 - h. Verify proper charger operation.
 - i. Document, sign, and date test results.

5. **On-Site Operational Training:** During the factory-assisted start-up, operational training for site personnel shall include, but shall not be limited to, key pad operation, LED indicators, start-up and shutdown procedures, maintenance bypass and AC disconnect operation, and alarm information.

3.3 FIELD QUALITY CONTROL

A. **Manufacturer Field Service:**

1. **Worldwide Service:** The UPS manufacturer shall have a worldwide service organization available, consisting of factory-trained field service personnel to perform start-up, preventative maintenance, and service of the UPS system and power equipment. The service organization shall offer 24 hours a day, 7 days a week, 365 days a year service support.
2. **Replacement Parts:** Parts shall be available through the worldwide service organization 24 hours a day, 7 days a week, and 365 days a year. The worldwide service organization shall be capable of shipping parts within four working hours or on the next available flight, so that the parts may be delivered to the Owner within 24 hours.

3.4 DEMONSTRATION

- #### A. **General:** Provide the services of a factory-authorized service representative of the manufacturer to provide start-up service and to demonstrate and train the Owner's personnel.
1. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
 2. Train the Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventive maintenance.
 3. Review data in operation and maintenance manuals with the Owner's personnel.
 4. Schedule training with the Owner, through the Architect/Engineer, with at least seven day's advanced notice.
- #### B. **UPS Training Workshop:** A UPS training workshop shall be available from the UPS manufacturer. The training workshop shall include, but shall not be limited to, a combination of lecture and practical instruction with hands-on laboratory sessions. The training workshop shall include, but shall not be limited to, instruction about safety procedures, UPS operational theory, sub-assembly identification and operation, system controls, adjustments, preventative maintenance, and troubleshooting.

3.5 PROTECTION

- #### A.
- Provide final protection and maintain conditions in a manner acceptable to the Installer that shall ensure that the solid state UPS shall be without damage at time of Substantial Completion.

END OF SECTION

CHECK LIST FOR GUIDE SPECIFICATION

Type of UPS					
Total rated power (kVA) at PF 1			kVA		kW
Manufacturer					
Range of products					
Operating mode (IEC 62040-3)	double conversion VFI	yes		no	
Worldwide UPS platform	Can be wired as 380/400/415 V or 480 V system	yes		no	
Operating temperature	0 to 40 °C without power derating	yes		no	
Modular architecture					
Power module	Fast serviceability and reduced maintenance requirements	yes		no	
Battery module	Fast serviceability and reduced maintenance requirements	yes		no	
Intelligence module	Fast serviceability and reduced maintenance requirements	yes		no	
Static Switch module	Fast serviceability and reduced maintenance requirements	yes		no	
Scalable architecture					
Power	Add power, in 25 kW increments, up to 500 kW per single UPS	yes		no	
Battery	Maintain or extend runtime as the load increases	yes		no	
Parallel capability	Up to 2 MW (for N+0 system level redundancy)	yes		no	
	Up to 1.5 MW (for N+1 system level redundancy)	yes		no	
Rectifier					
Input voltage range	340 V to 477 V (100% Load) 200 V to 477 V (50% Load)	yes		no	
Input frequency range	40 to 70 Hz (autosensing)	yes		no	
Phase sequence	UPS detects a wrong phase rotation	yes		no	
Sinusoidal input current	THDI upstream \leq 5% with PFC rectifier	yes		no	
Input power factor	PF > 0.995 at 100% load PF > 0.99 at 50% load PF > 0.97 at 25% load	yes		no	
No inrush or start-up current		yes		no	
Rapid battery recharging	Typical 5-min. backup time recharged in 3.5 hours	yes		no	
Redundant charger	Optional N+1 internal redundancy configuration	yes		no	
Redundant components					
Power	Optional N+1 internal redundancy configuration	yes		no	
Battery	Standard configuration. Battery modules connected in parallel.	yes		no	
Intelligence	Standard configuration. Parallel communication paths to critical UPS functions.	yes		no	

Battery					
Type	sealed lead acid enclosed in a cartridge		yes		no
Service life		years	yes		no
Backup time		minutes	yes		no
Battery management and protection					
Temperature compensated battery charging			yes		no
UPS incorporates a battery management system to continuously monitor the health of each battery module.			yes		no
Charge-current limiting	10 % or 20% of installed power rating		yes		no
Self-tests			yes		no
Determination of available runtime			yes		no
Inverter					
Output power factor	1		yes		no
Output power factor <u>without</u> derating	0.5 leading to 0.5 lagging		yes		no
Three-phase output voltage		Volts	yes		no
Steady-state conditions	± 1%		yes		no
Voltage transients	± 5% (load from 0 to 100% or 100 to 0%)		yes		no
Output frequency		Hz	yes		no
Variation in output frequency	± 0.1 Hz		yes		no
	adjustable from	± 0.1 Hz to ± 10 Hz	yes		no
Overload capacity	125% for 10 minutes		yes		no
	150% for 60 second		yes		no
Current limiting	250% to 300% In for 150 milliseconds		yes		no
	(e.g. 300% for 250 kVA and 250% for 300 kVA)		yes		no
Crest factor	up to 2.7:1		yes		no
Bypass functions					
Automatic bypass	With static switch		yes		no
Overload capacity	125% continuous (for 480 V systems) 110% continuous (for 400/415 V systems)		yes		no
Short-circuit withstand of static switch	10X system capacity for up to 100 ms		yes		no
Manual bypass	Mechanical (for maintenance)		yes		no
Efficiency					
Double conversion mode	> 96% from 41% load		yes		no
Independent laboratory test report	TÜV, other		yes		no
EcoMode	>99% efficiency in good power conditions		Yes		no
User interface					
Display	Multi-languages		yes		no
	personalization menu		yes		no
	display		yes		no
	event log		yes		no
Virtual Display	Remote monitoring with familiar touch screen graphical user interface		yes		no
Controls	EPO terminal block		yes		no
Status indications	Audio alarm, LEDs		yes		no
Communication					
Programmable relay card			yes		no
EPO terminal block			yes		no
Options	Card	JBus/ModBus RS485 + Ethernet 10/100	yes		no
	Supervision		yes		no

	software				
	Administration software	with shutdown management	yes		no
Certification					
Performance certification	TÜV		yes		no
Quality certification	ISO 9001 / 9002		yes		no
OSHPD pre-approved			yes		no
Eco-design and manufacturing	ISO 14001 site		yes		no
Services					
Technical competency of supplier	level 4 NFX 060-010		yes		no
Diagnostics and monitoring	remote		yes		no
Technical support	international		yes		no
Maintainability					
Access to components through front			yes		no
	Power		yes		no
	Battery		yes		no
	Bypass static switch		yes		no
	Intelligence module		yes		no
	Maintenance Bypass		yes		no
	DC disconnect switch		yes		no
	Network communication card		yes		no
	Power distribution unit		yes		no
Component replacement by a trained user			yes		no
MTTR	Individual module or component can be replaced in less than 10 min.		yes		no
Availability					
Availability of original replacement parts	around the world		yes		no
Response time of Service teams			t < 4h	4<t<8	8<t<24
				t>24 h	
Maintenance programs	preventive		yes		no
	predictive		yes		no
Emergency services			yes		no
Renovation / substitution programs			yes		no
Output synchronization to external source			yes		no
MegaTie			yes		no