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SECTION 16264 - STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. All sections of Division 15 and 16 apply to this section.

1.2 SUMMARY

- A. This Section includes three-phase, on-line, double-conversion, static-type, UPS installations complete with transient voltage surge suppression, input harmonics reduction, rectifier-charger, battery, battery disconnect device, inverter, static bypass transfer switch, and internal maintenance bypass/isolation switch.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. LCD: Liquid-crystal display.
- C. LED: Light-emitting diode.
- D. THD: Total harmonic distortion.
- E. UPS: Uninterruptible power supply.

1.4 SUBMITTALS

- A. Product Data: Include data on features, components, ratings, and performance for each UPS component indicated.
- B. Shop Drawings: Detail assemblies of equipment indicating dimensions, weights, components, heat dissipation and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
 - 1. Power, signal, and control wiring diagrams.
 - 2. Detailed layouts of customer power and control connections.

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3. Detailed installation drawings including all terminal locations.
- C. Qualification Data: For Installer and power quality specialist.
- D. Manufacturer Certificates: For each product, signed by manufacturers.
- E. Factory Test Reports: Comply with specified requirements.
- F. Field Quality-Control and Performance Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.
- G. Operation and Maintenance Data: For UPS units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data", include the following:
 1. Lists of spare parts and replacement components recommended being stored at Project site for ready access.
 2. Intended operation narrative with detailed operating instructions covering operation under both normal and abnormal conditions.
 3. Tools Required
 4. Recommended maintenance practices
 5. Manufacturer service department contact information
 6. Submittal Data
- H. Warranties: Provide complete manufacturers warranty information on all products provided.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
- B. Power Quality Specialist Qualifications: A factory-trained registered professional electrical engineer or engineering technician, currently certified by the National Institute for Certification in Engineering Technologies, NICET Level 4, minimum, experienced in performance testing UPS installations and in performing power quality surveys similar to that required in Part 3 "Performance Testing" Article.
- C. Manufacturer Qualifications: A minimum of twenty years experience in the design, manufacture, and testing of solid-state UPS systems is required. The system shall be designed and manufactured according to world class quality standards. The manufacturer shall be ISO 9001 certified. Maintain, within 50 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs with four hours maximum on-site service response time.
- D. Manufacturer Service Qualifications:

1. The UPS manufacturer shall directly employ a nationwide service organization. The service personal shall be the manufacturers employees and consisting of factory trained field service personnel dedicated to the start-up, maintenance, and repair of UPS and power equipment. Third party or non-manufacturer employees are not allowed. The organization shall consist of regional and local manufacturer offices. A minimum of 5 dedicated manufacturer field service employees trained in three phase UPS service shall be based within 50 miles of the site.
 2. The manufacturer shall provide a fully automated national dispatch center to coordinate field service personnel schedules. One toll-free number shall reach a qualified support person 24hours/day, 7days/week, and 365 days/year. If emergency service is required, response time shall be 20 minutes or less with 4 hours on site service response.
 3. An automated procedure shall be in place to insure that the manufacturer is dedicating the appropriate technical support resources to match escalating customer needs.
 4. Parts shall be available through an extensive network to ensure around-the-clock parts availability throughout the country.
 5. Recommended spare parts shall be fully stocked by local field service personnel with back-up available from national parts center and the manufacturing location. The national parts center Customer Support Parts Coordinators shall be on-call 24 hours/day, 7 days/week, and 365 days/year for immediate parts availability. Parts from the national parts center shall be shipped within 4 hours on the next available flight out and delivered to the customer's site within 24 hours.
- E. Source Limitations: Obtain the UPS and associated components specified in this Section from a single manufacturer with responsibility for entire UPS installation.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the City of Chicago Electrical Code by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- G. UL Compliance: Listed and labeled under UL 1778.
- H. NFPA Compliance: Mark UPS components as suitable for installation in computer rooms according to NFPA 75.
- I. Comply with NFPA 101 and the City of Chicago Electrical Code.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.
 - B. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

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1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
 - 1. Fuses: One for every 10 of each type and rating, but no less than 1 of each.
 - 2. Cabinet Ventilation Filters: One complete set.

1.8 LEED REQUIREMENTS

- A. Within 30-days after the date of system acceptance, record drawings of the actual installation shall be provided to the building owner.
- B. Implement an independent commissioning authority to review the contractor submittals relative to systems being commissioned.
- C. Implement providing the owner with a single manual that contains the information required for re-commissioning building systems.
- D. Use a UPS that is manufactured regionally within a radius of 500 miles.

1.9 WARRANTY

- A. Battery Warranties: The battery manufacturer's standard warranty shall be passed through to the end user. The battery manufacturer's standard warranty shall warrant the battery against defects in workmanship and materials for a period of one year from the date of manufacture.
- B. UPS Warranties: The UPS manufacturer shall warrant the UPS module against defects in materials and workmanship for 12-months after initial start-up or 18-months after ship date, whichever period expires first.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. UPS Module
 - a. Liebert Corporation
 - b. MGE UPS Systems
 - c. Powerware

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2. Battery
 - a. C&D Dynasty
 - b. Enersys Data Safe
 - c. GNB Absolyte IIP

2.2 PERFORMANCE DESCRIPTION

A. Automatic operation includes the following:

1. Normal Conditions: Supply the load with ac power flowing from the normal ac power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.
2. Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to maintain constant, regulated inverter ac power output to the load without switching or disturbance.
3. If normal power fails, energy supplied by the battery through the inverter continues supply-regulated ac power to the load without switching or disturbance.
4. When power is restored at the normal supply terminals of the system, controls automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger then supplies power to the load through the inverter and simultaneously recharges the battery.
5. If the battery becomes discharged and normal supply is available, the rectifier-charger charges the battery. On reaching full charge, the rectifier-charger automatically shifts to float-charge mode.
6. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch switches the load to the normal ac supply circuit without disturbance or interruption.
7. If a fault occurs in the system supplied by the UPS, and current flows in excess of the overload rating of the UPS system, the static bypass transfer switch operates to bypass the fault current to the normal ac supply circuit for fault clearing.
8. When the fault has cleared, the static bypass transfer switch returns the load to the UPS system.
9. If the battery is disconnected, the UPS continues to supply power to the load with no degradation of its regulation of voltage and frequency of the output bus.

B. Manual operation includes the following:

1. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the bypass source without disturbance or interruption.
2. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.

- C. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection between the following three conditions without interrupting supply to the load during switching:
1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.
 2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
 3. Normal: Normal UPS ac supply terminals are energized and the load is supplied through either the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.

2.3 SERVICE CONDITIONS

- A. Environmental Conditions: The UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance.
1. Operating Ambient Temperature for Electronic Components: 32 to 104 deg F.
 2. Storage/Transport Ambient Temperature for Electronic Components: -4 to 158 deg F.
 3. Operating Ambient Temperature for Battery: 77 +/- 9 deg F.
 4. Storage/Transport Ambient Temperature for Battery: -4 to 92 deg F.
 5. Relative Humidity: 0 to 95 percent, no condensing.
 6. Operating Altitude: Mean Sea level to 6,600 feet. Derated for higher altitude applications.
 7. Storage/Transport Altitude: Mean Sea level to 40,000 feet.

2.4 SYSTEM DESIGN REQUIREMENTS

- A. UPS Voltage: Input/Output and bypass voltage of the UPS shall be as shown on the drawings.
- B. UPS Output Load Capacity: Specified output load capacity of the UPS shall be as shown on the drawings and shall have a 0.8 lagging power factor.
- C. Battery Cells: Sealed, lead-acid, valve-regulated.
- D. Battery Reserve Time: The reserve time shall be as shown on the drawings and based on full load, 0.8 power factor, with ambient temperature between 68 to 86 deg F.
- E. Battery Recharge Time: Recharge to 95% capacity within ten (10) times discharge time.

- F. Unbalanced Load: The percentage of continuously unbalanced load is as shown on the drawings.

2.5 PERFORMANCE REQUIREMENTS

- A. The UPS shall perform as specified in this Article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a load crest factor of 3.0, under the following conditions or combinations of the following conditions:
 1. Inverter is switched to battery source.
 2. Steady-state ac input voltage deviates up to plus 10 or minus 20 percent from nominal voltage.
 3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
 4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
- B. Overall UPS Efficiency: Equal to or greater than the efficiencies in the following table:

NOMINAL OVERALL UPS EFFICIENCY RATINGS			
SIZE RANGE OF UPS UNITS	EFFICIENCY AT 100% RATED LOAD	EFFICIENCY AT 75% RATED LOAD	EFFICIENCY AT 50% RATED LOAD
30 kVA and Smaller	86	85	84
37.5 to 74 kVA	89	88	87
75 to 124 kVA	90	88	87
125 to 224 kVA	90	89	88
225 kVA and Larger	90	89	88

- C. Maximum Acoustical Noise: Noise generated by the UPS under any condition of normal operation shall not exceed 65 dBA measured 3 feet from the nearest surface of the UPS.
- D. Maximum Energizing Inrush Current: Eight times the full-load current.
- E. Maximum AC Output-Voltage Regulation:

1. Plus or minus 0.5 percent three-phase RMS average for a balanced three-phase load for the combined variation effects of input voltage, connected load, battery voltage, ambient temperature, and load power factor.
 2. Plus or minus 1.0 percent three-phase RMS average for a 100% unbalanced load for the combined variation effects of input voltage, connected load, battery voltage, ambient temperature, and load power factor.
- F. Output Frequency: Nominal frequency plus or minus 0.1 percent over the full range of input voltage, load, and battery voltage.
- G. Limitation of harmonic distortion of input current to the UPS shall be as follows:
1. Description: A tuned harmonic filter shall limit THD to 10 percent, maximum, at rated full UPS load current.
- H. Maximum AC Output Voltage Distortion:
1. 1 percent total harmonic distortion (THD) for linear loads.
 2. 2.5 percent THD for 100 percent nonlinear loads (3:1) crest factor) without kVA/kW derating.
- I. Minimum Overload Capacity of UPS at Rated Voltage in all operating modes:
1. 125 percent of rated full load for 10 minutes
 2. 150 percent for one minute
 3. 200 percent for 10 cycles, pulse paralleling with the static switch
- J. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 100 ms:
1. 50 Percent: Plus or minus 5 percent.
 2. 100 Percent: Plus or minus 2.5 percent.
 3. Loss of AC Input Power: Plus or minus 1 percent.
 4. Restoration of AC Input Power: Plus or minus 1 percent.
 5. Manual transfer of 100% load: Plus or minus 3 percent
- K. Input Power Factor: Between 0.90 – 0.96 lagging minimum from full load to half load with nominal input voltage.
- L. Input Current Limit:
1. 115 percent of nominal AC input current maximum
 2. 100 percent of nominal for optimal generator operation

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- M. Input Current Walk-In: 15 seconds to full rated input current maximum. Field selectable 5 through 15 seconds.
- N. Output Frequency Slew Rate: 5.0 Hertz per second maximum. Field selectable from 0.1 to 5.0 Hz per second.
- O. Output Phase Displacement:
 - 1. Plus or minus 0.5 degrees for balanced load
 - 2. Plus or minus 1.0 degrees for 100% unbalanced load
- P. Output Bypass Line Sync Range:
 - 1. Plus or minus 0.5 Hertz
 - 2. Field selectable plus or minus 0.5 to 5.0 Hertz
- Q. Output Power Rating: Rated kVA at 0.8 lagging power factor
- R. Inverter Output Voltage Adjustment: Plus or minus 5% manual adjustment
- S. Load Power Factor Range: 1.0 to 0.7 lagging without derating
- T. Transient Recovery Time: to within 1% of output voltage within one cycle.
- U. AC Output Voltage Unbalance: 100% unbalanced load plus or minus 1 percent
- V. Fault Clearing: Sub-cycle current of at least 300 percent
- W. EMI Emissions: Comply with FCC Rules and Regulations, and with 47 CFR 15 for Class A equipment.

2.6 UPS SYSTEMS

- A. General:
 - 1. All materials of the UPS shall be new, of current manufacture, high grade and free from all defects and shall not have been in prior service except as required during factory testing.
 - 2. The maximum working voltage, current, and di/dt of all solid-state power components and electronic devices shall not exceed 75% of the ratings established by their manufacturer.
 - 3. The operating temperature of solid-state component sub-assembly shall not be greater than 75% of their ratings.
 - 4. Electrolytic capacitors shall be computer grade and be operated at no more than 95% of their voltage rating at the maximum rectifier charging voltage.

5. Wiring practices, materials and coding shall be in accordance with the requirements of the City of Chicago Electrical Code.
 6. All bolted connections of bus bars, lugs and cables shall be in accordance with requirements of the City of Chicago Electrical Code.
 7. All electrical power connections are to be torqued to the required value and marked with a visual indicator.
 8. Provision shall be made for power cables to enter or leave from the top or bottom of the UPS cabinet.
- B. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.
- C. Enclosures:
1. The UPS unit, comprised of input transformer (if required), rectifier/charger with input filter, inverter, static transfer switch output transformer and maintenance bypass switch, shall be housed in a single free-standing NEMA Type 1 enclosure, unless otherwise indicated.
 2. Cabinet doors/covers shall require a tool for gaining access.
 3. Casters and stops shall be provided for ease of installation.
 4. Front access only shall be required for expedient servicing, adjustments, and installation.
 5. The UPS cabinet shall be structurally adequate and have provisions for hoisting, jacking, and forklift handling.
 6. The UPS cabinet shall be cleaned, primed, and painted with the manufacturer's standard color.
 7. The UPS shall be constructed of replaceable subassemblies. Like assemblies and like components shall be interchangeable.
- D. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.
- E. Surge Protection: Sustains input surges without damage per criteria listed in ANSI C62.41 Category A and B.
- F. Maintainability Features: Mount rectifier-charger and inverter sections and the static bypass transfer switch on modular plug-ins, readily accessible for maintenance.
- G. UPS Cabinet Ventilation: Cooling of the UPS shall be by forced air. Low-velocity fans shall be used to minimize audible noise output. Fan power shall be provided by the UPS output. The thermal design, along with all thermal and ambient sensors, shall be coordinated with the protective devices before excessive component or internal cabinet temperatures are exceeded.
- H. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.
- I. Grounding: The AC output neutral shall be electrically isolated from the UPS chassis. The UPS chassis shall have an equipment ground terminal. Provisions for local bonding shall be provided.

- J. Input Transformer: Where required, the input transformer shall be factory installed inside the UPS module cabinet without increasing the standard footprint.

2.7 RECTIFIER-CHARGER

- A. General: The rectifier/charger shall be a phase-controlled, solid-state SCR type with constant voltage/current limiting control circuitry.
- B. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.
- C. AC Input Current Limiting: The rectifier/charger unit shall be provided with AC input current limiting whereby the maximum input current shall be limited to 115 percent of the full input current rating. The rectifier/charger shall operate at a reduced current limit mode whenever the critical load is powered from the UPS static bypass circuit such that the maximum UPS input current will not exceed 115 percent of full load input current. In addition, the rectifier/charger shall have a separate battery current limit, adjustable from 0 to 15 percent of the full load input current. An optional second circuit shall limit the battery recharge current to zero when activated by a customer-supplied contact closure to signal a customer function such as generator operation.
- D. Input Current Walk-In: The rectifier/charger shall contain a timed walk-in circuit that causes the unit to gradually assume the load over a 15-second time interval after input voltage is applied. Walk-in time shall be field selectable for 5 through 20 seconds. If applicable, coordinate this time for maximum compatibility with local generator-set power source.
- E. Output Ripple: The rectifier/charger shall have an output filter to minimize ripple voltage into the battery. Under no conditions shall ripple voltage into the battery exceed 1% RMS. The filter shall be adequate to insure that the DC output of the rectifier/charger will meet the input requirements of the inverter. The inverter shall be able to operate from the rectifier/charger with the battery disconnected.
- F. Fuse Failure Protection: Power semiconductors in the rectifier/charger shall be fused with fast-acting fuses, so that loss of any one power semiconductor shall not cause cascading failures.
- G. Rectifier-Charger Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.
- H. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life.
- I. Automatic Rectifier Restart: Upon restoration of utility AC power, after a utility AC power outage and prior to a UPS automatic end-of-discharge shutdown, the rectifier/charger shall automatically restart, walk-in, and gradually assume the inverter and battery recharge loads.

- J. Over-voltage Protection: There shall be DC over-voltage protection so that if the DC voltage rises to the pre-set limit, the UPS is to shut down automatically and initiate an uninterrupted load transfer to the static bypass line.
- K. Input Filter: The rectifier/charger shall include an input filter to reduce reflected input current distortion to 10% THD at full load with nominal input voltage. The input filter shall maintain the input power factor at 0.90 0 0.96 lagging minimum from full load to half load with nominal input voltage. The input filter shall have a disconnect that automatically disconnects the filter under low load conditions.

2.8 INVERTER

- A. Description: The term inverter shall denote the solid-state equipment and controls to convert DC power from the rectifier/charger or battery to regulated AC power for supporting the critical load. The inverter shall use Insulated Gate Bipolar Transistors (IGBTs) in a phase-controlled, pulse width modulated (PWM) design capable of providing the specified AC output.
- B. Overload Capability: The inverter shall be capable of supplying current and voltage for overloads exceeding 100 percent and up to 200 percent of full load current. A status indicator and audible alarm shall indicate overload operation. The UPS shall transfer the load to bypass when overload capacity is exceeded.
- C. Fault Clearing and Current Limit: The inverter shall be capable of supplying an overload current of 150 percent of its full-load rating for one minute. For greater currents or longer time duration, the inverter shall have electronic current-limiting protection to prevent damage to components. The critical load will be transferred to the static bypass automatically and uninterrupted. The inverter shall be self-protecting against any magnitude of connected output overload. Inverter control logic shall sense and disconnect the inverter from the critical AC load without the requirement to clear protective fuses.
- D. Step Load Response: The output voltage shall be maintained to within plus or minus 2.5 percent with a 0-to-100 percent step load change or a 100-to-0 percent load change. The output voltage shall recover to within 1 percent of nominal voltage within 1 cycle.
- E. Voltage Distortion: For linear loads, the output voltage total harmonic distortion (THD) shall not be greater than 1 percent. For 100 percent rated load of 3:1 crest factor nonlinear loads, the output voltage total harmonic distortion shall not be greater than 2.5 percent. The output rating is not to be derated in kVA or kW due to the 100 percent nonlinear load with 3:1 crest factor.
- F. Output Power Transformer: Where necessary, a dry-type power transformer shall be provided for the inverter AC output. It shall have copper wiring exclusively. The transformers hottest spot winding temperature shall not exceed the temperature limit of the transformer insulation class of material when operating at full load at maximum ambient temperature.
- G. Phase Balance: Electronic controls shall be provided to regulate each phase so that an unbalanced loading will not cause the output voltage to go outside the specified voltage

unbalance or phase displacement. With 100 percent load on one phase and 0 percent load on the other 2 phases or 100 percent load on 2 phases and 0 percent load on the other phase, the voltage balance is to be within 1 percent and the phase displacement is to be 120 degrees within plus or minus 1 degree.

- H. Fuse Failure Protection: Power semiconductors in the inverter unit shall be fused with fast-acting fuses, so that loss of any one power semiconductor will not cause cascading failures.
- I. Inverter Shutdown: For rapid removal of the inverter from the critical load, the inverter control electronics shall instantaneously turn off the inverter transistors. Simultaneously, the static transfer switch shall be turned on to maintain continuous power to the critical load.
- J. Inverter DC Protection: The inverter shall be protected by the following disconnect levels:
 - 1. DC Over-voltage Shutdown
 - 2. DC Under voltage Warning (Low Battery Reserve), user adjustable from 1 to 99 minutes
 - 3. DC Under voltage Shutdown (End of Discharge)
- K. Over discharge Protection: To prevent battery damage from over discharging, the UPS control logic shall automatically raise the shutdown voltage set point as discharge time increases beyond fifteen (15) minutes.
- L. Inverter Output Voltage Adjustment: The inverter shall use a software control to adjust the output voltage from plus or minus 5 percent of the nominal value.
- M. Output Frequency: The output frequency of the inverter shall be controlled by an oscillator. The oscillator shall be temperature compensated and hold the inverter output frequency to plus or minus 0.1 percent for steady state and transient conditions. Drift shall not exceed 0.1 percent during a 24-hour period. Total frequency deviation, including short time fluctuation and drift, shall not exceed 0.1 percent from the rated frequency.

2.9 STATIC BYPASS TRANSFER SWITCH

- A. General:
 - 1. A static transfer switch and bypass circuit shall be provided as an integral part of the UPS. The static switch shall be a naturally commutated high-speed static (SCR-type) device rated to conduct full load current continuously, The switch shall have an overload rating of 110 percent rated load continuously, 200 percent rated load for five seconds. The static transfer switch shall also have fault-clearing capabilities of 1100 amperes for 1 second, 3000 amperes for 10 cycles, and 6000 amperes peak for the first half cycle.
 - 2. The static transfer switch control logic shall contain an automatic transfer control circuit that senses the status of the inverter logic signals, and operating and alarm conditions. This control circuit shall provide an uninterrupted transfer of the load to an alternate bypass source, without exceeding the transient limits specified herein, when an overload or malfunction occurs within the UPS, or for bypassing the UPS for maintenance.

B. Uninterrupted Transfer:

1. The transfer control logic shall automatically turn on the static transfer switch, transferring the critical AC load to the bypass source, after the transfer logic senses any of the following conditions:
 - a. Inverter overload capacity exceeded
 - b. Critical AC load overvoltage or under voltage
 - c. Battery protection period expired
 - d. UPS fault condition
2. The transfer control logic shall inhibit an automatic transfer of the critical load to the bypass source if any of the following conditions are present:
 - a. Inverter/bypass voltage difference exceeding preset limits
 - b. Bypass frequency out of limits
 - c. Bypass out-of-synchronization range with inverter output

C. Uninterrupted Retransfer: Retransfer of the critical AC load from the bypass source to the inverter output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall inhibit an automatic retransfer of the critical load to the inverter if one of the following conditions exists:

1. Bypass out of synchronization range with inverter output
2. Inverter/bypass voltage difference exceeding preset limits
3. Overload condition exists in excess of inverter full load rating
4. UPS fault condition present

2.10 BATTERY

A. Description:

1. The battery power pack shall include sealed, lead-acid valve regulated battery cells housed in a separate cabinet that matches the UPS cabinet styling to form an integral system line-up.
2. Battery cells shall be mounted on slide-out trays for ease of maintenance.
3. A battery disconnect circuit breaker with under voltage release (UVR) shall be included for isolation of the battery pack from the UPS module. The UPS shall automatically be disconnected from the battery by opening the breaker when the battery reaches the minimum discharge voltage level.
4. Casters and leveling feet shall also be provided with the battery power pack cabinet for ease of installation.
5. When the application calls for the battery cabinet to be bolted to the UPS cabinet, the interconnecting cables are to be provided, pre-cut and pre-plugged.

2.11 CONTROLS AND INDICATIONS

- A. Description: The UPS shall be provided with a microprocessor based unit status display and controls section designed for convenient and reliable user operation. A graphical display shall be used to show a single-line diagram of the UPS, and shall be provided as part of the monitoring and controls sections of the UPS. All of the operator controls and monitors shall be located on the front of the UPS cabinet. The monitoring functions such as metering, status and alarms shall be displayed on the graphical LCD display. Additional features of the monitoring system shall include:
1. Menu-driven display with pushbutton navigation
 2. Real time clock (time and date)
 3. Alarm history with time and date stamp
 4. Battery backed-up memory
- B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items.
- C. Metering: The following parameters shall be displayed:
1. Input AC voltage for each phase, line-to-line
 2. Input AC current for each phase
 3. Input frequency
 4. Battery voltage
 5. Battery current and direction (charge/discharge)
 6. DC bus voltage
 7. Output AC voltage line-to-line and line-to-neutral for each phase
 8. Output AC current for each phase
 9. Output frequency
 10. Percent of rated load being supplied by the UPS
 11. Battery time left during battery operation
- D. Status Messages: The following UPS status messages shall be displayed:
1. Normal operation
 2. On Static Bypass Transfer Switch
 3. Load on UPS
 4. Load on bypass
 5. User Shutdown
 6. Battery Discharging
- E. Alarm Messages: The following alarm messages shall be displayed and an audible alarm shall be provided and activated by any of the following alarm conditions:
1. Input Line Fault
 2. Input Phase Rotation Error

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3. Input Over/Under Frequency
4. Input Current Limit
5. Rectifier Fail
6. Battery Test Failed
7. Battery Low Warning (Adjustable 1 to 99 Minutes)
8. Battery Low Transfer
9. DC Overvoltage Steady State
10. Bypass Frequency Error
11. Load On Bypass
12. Excessive Auto Retransfers
13. Static Bypass Transfer Switch SCR Shorted
14. Bypass Sync Error
15. Input Phase Loss
16. DC Current Peak
17. Output Under voltage Transfer
18. Output Overvoltage Transfer
19. Inverter Overload
20. Static Bypass Transfer Switch Overload
21. Inverter Overload Transfer
22. Transfer Failed Shutdown
23. Hardware Shutdown
24. Output Power Supply Fail
25. Inverter Control Fault Transfer
26. System Fan Fail
27. Ambient Over temperature Limit
28. Over-temp Timeout Shutdown

F. Controls: UPS start-up, shutdown, and bypass operations shall be accomplished through the front-panel pushbutton controls. Menu-driven user prompts shall be provided to guide the operator through system operation without the use of additional manuals. Pushbuttons shall be provided to display the status of the UPS and to test and reset visual and audible alarms. A mimic screen shall be available on the LCD screen to depict a single-line diagram of the UPS, with switch positions and power flow. Pushbuttons shall include the following:

1. Inverter on-off.
2. UPS start.
3. Battery test.
4. Alarm silence/reset.
5. Output-voltage adjustment.

G. Programmable Relay Board: Eight sets of isolated Form C contacts shall be provided to indicate a change of status of any of the alarm conditions. Any of the UPS alarms can be programmed onto any channel of the programmable relay board.

H. On-Line Battery Test:

1. The UPS shall be provided with a menu-driven On-Line Battery Test Feature. The test shall ensure the capability of the battery to supply power to the inverter while the load is supplied power in the normal mode. If the battery fails the test, the system shall automatically do the following:
 - a. Maintain the load through the UPS
 - b. Display a warning message
 - c. Sound an audible alarm
 2. The battery test feature shall have the following user selectable options:
 - a. Interval between tests (2 to 9 weeks)
 - b. Date and time of initial test
 - c. Enable/disable test
- I. Emergency Power Off Switch: Capable of local operation and operation by means of activation by external dry contacts.

2.12 MAINTENANCE BYPASS/ISOLATION SWITCH

- A. Description: A manually operated maintenance bypass switch shall be incorporated into the UPS cabinet to directly connect the critical load to the bypass AC input power source, bypassing the rectifier/charger, inverter, and static transfer switch.
1. Switch shall be electrically and mechanically interlocked to prevent interrupting power to the load when switching to bypass mode.
 2. Switch shall electrically isolate other UPS components to permit safe servicing. A means to de-energize the static switch shall be provided when the UPS is in the maintenance bypass mode of operation
- B. Switch Rating: Continuous duty at rated full UPS load current.
- C. Maintenance Capability: With the critical load powered from the maintenance bypass circuit, it shall be possible to check out the operation of the rectifier/charger, inverter, battery, and static transfer switch.

2.13 MONITORING BY REMOTE STATUS AND ALARM PANEL

- A. Description: Labeled LEDs on panel faceplate indicate the following basic status conditions. Audible signal indicates alarm conditions. Silencing switch in face of panel silences signal without altering visual indication. The panel shall also be provided with a lamp test/reset pushbutton. The remote status panel shall be provided in a NEMA Type 1 enclosure for wall mounting.
1. Load on UPS LED
 2. Load on Bypass LED
 3. Battery Discharge LED

4. Low Battery Reserve LED
5. UPS Alarm Condition LED
6. New Alarm Condition LED (for a second UPS alarm condition)

2.14 BATTERY CIRCUIT BREAKER

- A. A battery circuit breaker shall be provided to isolate the battery from the UPS. This breaker shall have an under voltage release (UVR) and auxiliary contacts, and shall be in the battery cabinet. The battery breaker provides a manual disconnecting means, short circuit protection, and over current protection for the battery system. When opened, 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.

2.15 SOURCE QUALITY CONTROL

- A. Factory test complete UPS system before shipment. Use simulated battery testing. Include the following:
1. Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
 2. Full-load test.
 3. Transient-load response test.
 4. Overload test.
 5. Power failure test.
- B. Observation of Test: Give 14 days' advance notice of tests and provide opportunity for Owner's representative to observe tests at Owner's option.
- C. Report test results. Include the following data:
1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
 2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
 3. List of instruments and equipment used in factory tests.

2.16 EXTERNAL MAINTENANCE BYPASS CABINET

- A. A matching external maintenance bypass cabinet shall be provided to enable the UPS module to be completely isolated from the electrical system while the critical load is powered through the external maintenance bypass line. This optional cabinet shall provide make-before-break operation for transfers to and from the external maintenance bypass line with a single rotary switch. This matching cabinet shall bolt to the side of the UPS module with a barrier shield to separate the two cabinets. Only front access shall be required for installation and service.

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- B. The following components shall be standard:
1. Single rotary switch with auxiliary contacts
 2. Inter-cabinet wiring
 3. Casters
 4. Leveling feet

- C. The following components shall be optional:
1. Input circuit breaker
 2. Shielded isolation transformer
 3. Load (output) circuit breaker

2.17 INTERNAL MODEM

- A. The UPS shall come with an internal modem capable of dialing out from the UPS to notify up to two remote computers, terminals, PC's, or pocket pagers when important events occur. The modem will also be capable of accepting incoming calls, with the appropriate security, and connecting to a remote terminal, computer or PC, to perform all those functions normally available on the front panel including viewing monitoring screens.

2.18 SNMP

- A. The UPS shall come equipped with an internal Simple Network Management Protocol (SNMP) adapter, which will connect the UPS directly to any I.P. based network using Ethernet communications. The UPS will become a managed device on the network. From a network management station the system administrator shall be capable of monitoring important system measurements, alarm status and alarm history data. In the event of a utility failure the SNMP shall continue with live communication without the requirement of additional or separate UPS equipment until such time as the UPS shuts down for Low battery. On resumption of Utility power the SNMP shall resume full SNMP communication automatically.

2.19 OUTPUT ISOLATION TRANSFORMER

- A. Description: Unit with low forward transfer impedance up to 3 kHz, minimum. Include the following features:
1. Comply with applicable portions of UL 1561, including requirements for nonlinear load current-handling capability for a K-factor as specified on the drawings.
 2. Output Impedance at Fundamental Frequency: Between 3 and 4 percent.
 3. Regulation: 5 percent, maximum, at rated nonlinear load current.
 4. Full-Load Efficiency at Rated Nonlinear Load Current: 96 percent, minimum.
 5. Electrostatic Shielding of Windings: Independent for each winding.
 6. Coil Leads: Physically arranged for minimum interlead capacitance.

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7. Shield Grounding Terminal: Separately mounted; labeled "Shield Ground."
8. Capacitive Coupling between Primary and Secondary: 33 picofarads, maximum, over a frequency range of 20 Hz to 1 MHz.

2.20 OUTPUT DISTRIBUTION SECTION

- A. Panel boards: Comply with Division 16 Section "Panel boards," except provide assembly integral to UPS cabinet.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and the City of Chicago Electrical Code.
- B. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.

3.2 IDENTIFICATION

- A. Identify components and wiring according to Division 16 Section "Electrical Identification."

3.3 BATTERY EQUALIZATION

- A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.

3.4 FIELD QUALITY CONTROL

- A. The following inspections and test procedures shall be performed by factory-trained field service personnel during the UPS startup.
 1. Visual Inspection
 - a. Inspect equipment for signs of damage
 - b. Verify installation per drawings
 - c. Inspect cabinets for foreign objects
 - d. Verify neutral and ground conductors are properly sized and configured
 - e. Inspect battery cases
 - f. Inspect battery for proper polarity
 - g. Verify all printed circuit boards are configured properly

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2. Mechanical Inspection
 - a. Check all control wiring connections for tightness
 - b. Check all power wiring connections for tightness
 - c. Check all terminal screws, nuts, and/or spade lugs for tightness
3. Electrical Inspection
 - a. Check all fuses for continuity
 - b. Confirm input voltage and phase rotation is correct
 - c. Verify control transformer connections are correct for voltages being used
 - d. Assure connection and voltage of the battery string(s)

- B. Load Bank Testing: A 4-hour full load, load bank test shall be performed at the site. The resistive load bank shall be supplied by the contractor at no additional cost.
- C. Retest: Correct deficiencies and retest until specified requirements are met.
- D. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

3.5 MAINTENANCE CONTRACTS

- A. A complete offering of preventative and full service maintenance contracts for both the UPS system and battery system shall be available. An extended warranty and preventative maintenance package shall be available. Warranty and preventative maintenance service shall be performed by factory-trained service personnel.

3.6 CLEANING

- A. The contractor shall remove all paint spatters and other spots, dirt and debris from the equipment. Clean equipment and devices internally and externally using methods and materials recommended by the manufacturer.

3.7 CONTRACTOR STARTUP AND REPORTING

- A. Contractor shall prepare and submit a complete set of record drawings, test results, operation and maintenance data and certificates as outlined in this section.

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3.8 COMMISSIONING AND DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the UPS. Refer to Division 1 Section "Demonstration and Training."
- B. Engage a factory-trained field service personnel to perform field quality control tests as outlined in this Section.
- C. After system checkout and adjustment, the contractor shall operate the system for the review of the owner and architect. Necessary adjustments or modifications shall be made as required by the owner or architect.

END OF SECTION 16264