# SECTION 26 3353
# STATIC UNINTERRUPTIBLE POWER SUPPLIES

## PART 1 GENERAL

### 1.01 SUMMARY

A. This specification describes the continuously rated, solid state Uninterruptible Power System for maximum efficiency and power density. These systems provide continuous, regulated AC power to the equipment of datacenter, network, telecom and other critical equipment applications without any disturbances or disruptions occurring on the main power supply.

B. Specification defines the electrical and mechanical characteristics and requirements for a continuous-duty three-phase, solid-state, uninterruptible power supply system. The uninterruptible power supply system, hereafter referred to as the UPS, shall provide high-quality AC power. The manufacturer shall design and furnish all materials and equipment to be fully compatible with electrical, environmental and space conditions at the site. The system shall consist of a converter, N+1 VRLA battery system (2 cabinets), solid-state inverter, automatic static transfer circuit, and three breaker maintenance bypass with step-down transformer.

### 1.02 SUBMITTALS

A. Product Data: For each type of product indicated. Include data on features, components, ratings, and performance.

B. Shop Drawings: For UPS. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
   2. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified power quality specialist.

D. Manufacturer Certificates: For each product, from manufacturer.

E. Factory Test Reports: Comply with specified requirements.

F. Field quality-control reports.

G. Performance Test Reports: Indicate test results compared with specified performance requirements and provide justification and resolution of differences if values do not agree.

H. Operation and Maintenance Data: For UPS units to include in emergency, operation, and maintenance manuals.

I. Warranties: Sample of special warranties.

### 1.03 STANDARDS

A. The UPS shall be listed to the following UL/CSA standards. Where a conflict arises between these documents and statements made herein, the statements in this specification shall govern.
   1. UL 1778, 5th Edition - Uninterruptible Power Supply Equipment
   2. NFPA 70 - National Electrical Code
   3. IEEE 446 - Recommended Practice for Standby Power Systems
   4. IEEE C62.41 - Recommended Practice for Surge Withstand ability
   5. NEMA PE 1 - Uninterruptible Power Systems
   6. OSHA - Occupational Safety and Health Administration
   7. IBC – International Building Code (IBC2016)
   8. Quality System Standard ISO 9001
   9. OSHPD Certified and Listed - ABB Branded Models no GE

### 1.04 QUALITY ASSURANCE

A. Power Quality Specialist Qualifications: A 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 "Performance Testing" Article.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Manufacturer Qualifications
   1. A minimum of 10 years' experience in the design, manufacture, and testing of solid-state UPS systems is required.
   2. Prior to shipment the manufacturer shall complete a documented test procedure to test functions of the UPS module, and warrant compliance with this specification. The manufacturer shall provide a copy of the test report.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. UL Compliance: Listed and labeled under UL 1778 by an NRTL.

F. NFPA Compliance: Mark UPS components as suitable for installation in computer rooms according to NFPA 75.

## 1.05 WARRANTY

A. The UPS manufacturer shall guarantee warrant the UPS against defective materials and workmanship for period of five (5) year from date of shipment. With the purchase of factory start-up services, the manufacturer shall include labor and expenses for a period of five (5) year from date of factory start-up, not to exceed sixty-six (66) months from date of factory shipment. Warranty coverage is provided Monday-Friday, from 8 AM - 5 PM. The sixty months of warranty includes a major PM, years two through five. Warranty applies only to equipment manufactured by ABB. Other equipment is covered by the warranty of its manufacturer.

H. The UPS manufacturer shall include a complete preventive and full-service maintenance contract for the UPS system and preventive battery system contract with the battery manufacture warranty. Warranty and preventive maintenance service shall be performed by factory trained Customer Engineers

I. Service Personnel
   1. The UPS manufacturer shall directly employ a nationwide service organization, consisting of factory trained Customer Engineers dedicated to the start-up, maintenance, and repair of UPS and power equipment. The organization shall consist of factory-trained Field Engineers working out of most major cities.
   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 24 hours/day, 7 days/week, and 365 days/year

# PART 2 PRODUCTS

## 2.01 MANUFACTURERS

A. Buc-ee's has secured a special terms program with preferred vendor: Pinnacle Power Solutions (PPS). For details and pricing contact Brandon Stefan, brandon@pps-ups.com, 832-934-7775.
   1. Basis of Design:
      a. Model: Toshiba G9000 160KVA Series UPS
      b. UPS – Part Number #: T90S3S16KS6XSN2
      c. Maintenance Bypass – Part Number#: G9DC-0250H8XXWC63X
      d. Battery Cabinet(s) – Part Number # : G9B1160K013EDM1NH

B. Buc-ee's has secured a special terms program with preferred vendor: Strategic Protection Systems (SPS). For details and pricing contact Mark Batton, mark@sps-sales.com and Matthew Hallmark, matthew@sps-sales.com > 281-443-2080.
   1. Basis of Design:
      a. Model: FirstLine PE 160kVA UPS

b. UPS – FLE-200-01-U00S00-160 by STACO ENERGY.
c. Maintenance Bypass – FLU-P-160-TC-4D-2Y-MBPS-E by STACO ENERGY.
d. Battery Cabinet(s) – (2) FLE-BAT-505-400-1-EN by STACO ENERGY.

## 2.02 SYSTEM DESCRIPTION

A. General characteristics
1. The UPS shall be of transformer-free design, requiring no internal transformer in the main power path for the basic operation of the module.
2. System shall be made of 50kW Power Blocks, constructed to contain up to 3 in the same frame, allowing easy vertical power scalability within the same UPS module for field upgrade.
3. Modules shall be easily serviced from the front of the enclosure. Major consumable parts (fans, capacitors, etc.) shall be interchangeable, without the need of replacing the whole Power Block. Cable and conduit connections shall be through the bottom of the UPS enclosure and terminations can be made from the front of the UPS.
4. The UPS shall be sized to provide a minimum of 150 kVA/kW output (unity load power factor rating).
5. The UPS shall be able to supply all required power to full rated output kVA loads with power factor from 0.7 leading to 0.6 lagging.
6. Battery, Valve Regulated Lead Acid shall support the UPS at 100% rated kW load for at least 12 minutes at startup (initial run time) per cabinet or 28 minutes with both battery cabinets in parallel, at 77°F (25°C).
7. The UPS shall have an active power factor corrected three-level IGBT rectifier, capable of maintaining input power factor and input THDi within specifications without an additional input filter.

## 2.03 OPERATIONAL REQUIREMENTS

A. The UPS shall be designed to operate as a true on-line, double conversion Voltage and Frequency Independent (VFI) system in the following modes:

B. Normal - The critical AC load is continuously supplied by the UPS inverter. The input converter derives power from the utility AC source and supplies DC power to the inverter. The battery charger shall maintain a float-charge on the battery.

C. Battery - Upon failure of utility AC power the critical AC load is supplied by the inverter, which obtains power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.

D. Recharge - Upon restoration of utility AC power, after a utility AC power outage, the input converter shall automatically restart and resume supplying power to the inverter. Also, the battery charger shall recharge the battery.

E. Automatic Restart - Upon restoration of utility AC power, after a utility AC power outage and complete battery discharge, the UPS shall automatically restart and resume supplying power to the critical load on inverter.

F. Static-bypass - The static-bypass shall provide an alternate path for power to the critical load that shall be capable of operating in the following manner:
1. Automatic - In the event of an internal failure or should the inverter overload exceed its capacity, UPS module shall perform an automatic transfer of the critical AC load from the inverter to the bypass source.
2. Manual - Manual activation of the bypass shall cause an immediate transfer of the critical AC load from the inverter to the bypass source on all modules of the system.

## 2.04 PERFORMANCE REQUIREMENTS

A. General
1. UPS shall be located in well-ventilated areas, free from excess humidity, dust and dirt and from hazardous materials.

2. The UPS shall be designed for indoor installation with ambient temperatures from 32° - 104°F (0 - 40°C), 77°F ±5°F (25°C) for the battery and relative humidity from 0 - 95% non-condensing.
3. The UPS shall be designed for operation at an altitude of up to 1000 meters without derating.
4. UPS shall be a true on-line double conversion, belonging to the classification VFI in accordance with UL 1778, UL 60950-1, and IEC/EN 62040-3.

B. AC Input
1. Voltage: 480 VAC, 3-phase, 3 wire + ground
2. Voltage Range: +/-10% without discharging the battery.
3. Frequency: 60 Hertz +/-10% continuous.
4. Current Walk-In: 15 seconds to full load rating (programable)
5. Maximum Input Current: 120% of nominal full load current.
6. Power Factor: 0.99 at full load and nominal voltage.
7. Current Distortion (THDi): <= 3% input current THD at full load at nominal input voltage.
8. Rectifier and Bypass Surge Protection: module shall withstand tested according to IEC 62040-2:2016 that requires 1kV L-L and 2kV L-PE
9. Withstand Rating: UPS module shall carry 65kA standard for short circuit withstanding. System has been tested under the guidance of U.L. as to meet National Electrical Code.

C. AC Output
1. UPS Loading: 100% continuous load rating at 104F (40C)
2. Voltage: 480VAC, 3-phase, 3-wire + ground
3. Voltage Regulation: +/- 1% nominal voltage at balance load.
4. Voltage Adjustability: +/- 4% adjustable
5. Dynamic Regulation: +/- 3% from nominal for 0 to 100% step load. Recovering to within 1% in less than 1 cycle.
6. Efficiency: VFI mode at unity power factor load, with battery fully charged and floating ready for emergency backup:

| UPS Rating | 25% | 50% | 75% | 100% |
|---|---|---|---|---|
| 40 kVA/kw | 94.2% | 95.1% | 95.6% | 95.5% |
| 50 kVA/kw | 94.2% | 95.5% | 95.6% | 95.5% |
| 80 kVA/kw | 94.2% | 95.5% | 95.7% | 95.6% |
| 100 kVA/kw | 94.2% | 95.6% | 95.7% | 95.6% |
| 120 kVA/kw | 94.3% | 95.5% | 95.7% | 95.5% |
| 150kVA/kw | 94.3% | 95.7% | 95.7% | 95.4% |

7. Voltage unbalance: ±3% of nominal for 100% unbalanced loads
8. Phase Imbalance:
9. 120° ±1% of nominal for 100% balanced loads.
10. 120° ±3% of nominal for 100% unbalanced loads
11. Voltage Harmonic Distortion @Linear Load: <3% THD at 100% load
12. Voltage Harmonic Distortion @non-Linear Load: <5% THD at 100% load (per - IEC62040)
13. Frequency Stability: 60 HZ ±0.01% free running.
14. Phase-lock Window: 60 HZ, +/- 4% (adjustable).
15. Frequency Slew Rate: 0.1 Hz to 20 Hz/second, selectable in 0.1 Hz increments.

D. Inverter Overload:
1. 105% continuous operation
2. 110% for 10 minutes
3. 125% for 1 minute
4. 150% for 30 seconds

E. Static Bypass Overload:
   1. 110% Continuous (at 25°C Ambient temperature)
   2. 150% for 1 minute

F. Fault Clearing Capability Inverter:
   1. 200% for 200ms
   2. 220% for 100mSeconds
   3. 700% for 1.2mSeconds

G. Fault Clearing Capability Bypass
   1. 1000% for half cycle
   2. Crest Factor: 3:1 with THD <3%

H. Grounding
   1. UPS cabinet shall have a grounding terminal.

**2.05 ENVIROMENTAL CONDITIONS**

A. The UPS system shall be designed to operate continuously at full load without degradation of its reliability, operating characteristics or service life in the following environmental conditions:
   1. UPS operation ambient temperature range 0°C to 40°C,
   2. Battery ambient temperature range 20°C to 25°C
   3. Humidity (relative) ≤ 95% non-condensing
   4. Storage: UPS -25 deg C to +55 deg °C; Battery -20 deg C to 25 deg °C for maximum 6 months

B. The UPS system shall be designed for operation in altitudes up to 1000 meters, without the need for de-rating or reduction of the above environmental operating temperatures.

C. The UPS system cabinet shall comprise of a free-standing steel enclosure to house the power system, control systems, battery connections and all associated necessary connections for the correct operation of the UPS in accordance with the requirement of the specifications. All switchgear and interconnections must be adequately protected to enable an isolated section to be safely maintained or repaired whilst the remaining system supports the load.

**2.06 FABRICATION**

A. All materials and components making up the UPS shall be new, of current manufacture, and shall not have been in prior service except as required during factory testing. The UPS shall be constructed of replaceable subassemblies.

**2.07 WIRING**

A. Wiring practices, materials, and coding shall be in accordance with the requirements of UL 1778 and other applicable codes and standards. Input, output and battery wiring terminal shall support bottom cable entry as a standard configuration. Common input (rectifier and bypass) and DC Battery wiring shall be provided, for Line and Match installation.

**2.08 UPS SYSTEMS**

A. The UPS system shall consist of a UPS module and a battery. UPS modules shall be of double conversion, and continuous duty (true on-line). The AC output of the UPS module shall be connected to the critical loads. The battery shall be connected to the DC input of the UPS. The UPS configuration shall be a single module rated to supply the load as specified herein. UPS module shall **have built-in back-feed protection** standard and not relying on upstream switchboard/switchgear. UPS system comprised of power section, input/output landing section with user interface module housed in a free-standing enclosure and meets the requirements of IP20 or NEMA1.

B. The UPS cabinet shall not exceed the following dimensions, and shall include Rectifier, Inverter, Static Bypass, Integrated Back-feed protection, Input & Output isolation contactor:

| UPS Rating | Width | Depth | Height | Weight |
|---|---|---|---|---|
| 40 kVA/kw | 23.6″ | 34″ | 64″ | 740 lbs. |
| 50 kVA/kw | 23.6″ | 34″ | 64″ | 740 lbs. |
| 80 kVA/kw | 23.6″ | 34″ | 64″ | 895 lbs. |
| 100kVA/kw | 23.6″ | 34″ | 64″ | 895 lbs. |
| 120 kVA/kw | 23.6″ | 34″ | 64″ | 1050 lbs. |
| 150 kVA/kw | 23.6″ | 34″ | 64″ | 1050 lbs. |

C. Construction and Mounting
   1. UPS shall be in a NEMA Type 1 enclosure, designed for indoor floor mounting. Enclosure shall have adequate provisions for lifting via forklift and jacking procedures. Enclosure shall not exceed 75" height as this maximum allowed in most electrical spaces. A floor-stand shall be provided for Line and Match installations. Matching the Battery Cabinets and Maintenance Bypass Cabinet.

D. Capacitor Assemblies
   1. All power, AC and DC capacitors shall be mounted allowing field replacement of the capacitors separately from power switching controls and components.

E. Cooling
   1. The UPS shall be forced air cooled by internally mounted fans.

**2.09 COMPONENTS**

A. Rectifier
   1. Incoming AC power shall be converted to a regulated DC output by the input converter for supplying DC power to the inverter. The input converter shall provide input power factor and input current distortion correction.

B. Input Protection
   1. The UPS shall have built-in protection against undervoltage, overcurrent, and overvoltage conditions including low-energy surges introduced on the primary AC source and the bypass source. The UPS system cabinet shall always contain an input isolation contactor.

C. Battery Recharge
   1. The Booster shall consist of DC choke and IGBT with control circuitry to provide constant voltage and constant current regulation to UPS DC link when working in battery mode. The booster shall recharge battery when the mains is available at the input of the UPS.
   2. Battery charge current is normally limited to the lesser of:
      a. 20% of the battery amp-hour rating (expressed in amps) and the difference in maximum rectifier output current and actual inverter input current. This will assure minimal battery recharge time while ensuring maximum battery life by limiting charge current to a safe level.
      b. Allowable battery charge current may be increased beyond 20% of the battery amp-hour rating for those applications requiring faster recharge times. Actual available charge current will still depend on output load level and power factor.
      c. Battery charging may be disabled via external contact closure, signaling operation on engine generator
      d. The rectifier/booster shall have sufficient capacity to supply the inverter at 100%, 1.0 PF load plus recharge a battery (sized for up to 30 minutes) to 95% of full capacity within ten (10) times the discharge time.

D. Inverter
   1. The inverter shall convert DC power from the input converter output, or the battery, into precise regulated sine wave AC power for supporting the critical AC load.
      a. Overload
   2. The inverter shall be capable of supplying current and voltage for overloads as below:

a. 105% continuous operation
b. 110% for 10 minutes
c. 125% for 1 minute
d. 150% for 30 seconds

3. A visual indicator and audible alarm shall indicate overload operation. For greater currents or longer time duration, the inverter shall have electronic current-limiting protection to prevent damage to components. 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. The load shall be transferred to bypass when any of the above conditions are exceeded.

E. Output Frequency
1. The output frequency of the inverter shall be controlled by an oscillator. The oscillator shall hold the inverter output frequency to +/- 0.1% for steady state and transient conditions. The inverter shall track the bypass continuously providing the bypass source maintains a frequency within the user selected via ABB field service engineer for the synchronization range. If the bypass source fails to remain within the selected range, the inverter shall revert to the internal oscillator.

F. Output Protection
1. The UPS system cabinet shall always contain an output isolation contactor.
2. Battery over Discharge Protection
3. To prevent battery damage from over discharging, the UPS control logic shall control the end of discharge voltage set point. This point is determined by an end of cell voltage level and takes into account the number of jars and backup time the battery system nominally provides. This information is configured on each active module display. This shall be configured at the factory or by authorized service personnel only.

G. Static Bypass
1. A 100% rated continuous duty static bypass circuit shall be provided as an integral part of the UPS module. The bypass 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 a transfer of the load to the bypass source, without exceeding the transient limits specified herein, when an overload or malfunction occurs within the UPS.

H. Automatic Transfers
1. The transfer control logic shall automatically activate the bypass, transferring the critical AC load to the bypass source, after the transfer logic senses one of the following conditions:
a. Inverter overload capacity exceeded
b. Inverter over temperature
c. UPS fault condition
2. For inverter overload conditions, the transfer control logic shall inhibit an automatic transfer of the critical load to the bypass source if one of the following conditions exists:
a. Inverter voltage less than 95% of nominal (adjustable).
b. Inverter voltage greater than 105% of nominal (adjustable).
c. Inverter overload period expired.
d. Inverter shutdown for any reason

I. Automatic Retransfer
1. The automatic retransfer of the load to the inverter provided all of the following conditions are met:
a. The inverter logic and the bypass AC power source are synchronized and in phase.
b. Inverter conditions are normal.
c. The UPS output is not overloaded.

J. Transfer Time
1. Maximum transfer time to switch from inverter to bypass AC power source shall be 100 microseconds.

2. Typical transfer time to switch from bypass to inverter is less than 2 mSec.
3. Display and Controls
4. The following parameters shall be measured and displayed by a graphical display on the UPS front panel. Each screen shall have the nomenclature of the parameter indicated with the associated value. AC voltage and current values shall be measured in true RMS units.
    a. Battery Display
    b. Battery voltage
    c. Battery current with flow direction
    d. Battery temperature
    e. Battery charge level
    f. Estimated backup time at present load
    g. Main Display
    h. Frequency
    i. Voltage – Phase-Neutral
    j. Bypass Status – Free/Locked
    k. Rectifier Display
    l. AC input voltage - phase to phase
    m. DC Bus voltage
    n. DC output current
    o. Input frequency

K. Inverter Display
1. Voltage
2. Output frequency.
3. Synchronization status.
4. Temperature

L. Systems Load – Screen 1
1. Voltage
2. Phase current
3. Load on Bypass
4. Load on Inverter (VFI) Mode
5. Load on eBoost (VI)Mode
6. Load OFF/On Battery
7. Load in percentage

M. Systems Load – Screen 2
1. Overall Load in KVA
2. Overall Load in kW
3. Load on Bypass
4. Load on Inverter (VFI) Mode
5. Load on eBoost (VI) Mode
6. Load OFF/On Battery
7. Power factor or Load in percentage (selectable)

N. Statistics display
1. Bypass Failure
2. Utility Failure
3. Overloads
4. UPS operating hours
5. Inverter operating hours (VFI) Mode
6. eBoost operating hours (VI) Mode

O. Audible Alarm and History
1. UPS alarm/event history shall be available through the alphanumeric display on the front panel. The event history shall store a minimum of 1,000 previous status and alarm events

with the date and time of each occurrence. No software or external remote monitoring equipment shall be necessary to access the alarm/event history.

2. The audible alarms shall warn for utility line loss, low battery (while on battery), and all other alarm conditions. For all alarm conditions, the user must look at the display to determine the cause of error/alarm. All alarm tones shall be a continual tone until the condition rectifies itself or the alarm is silenced. Once silenced, the audible alarm shall not sound until a new alarm condition is present, but the LED indication still warning the alarm condition.

P. Internal Diagnostic Memory
   1. The UPS shall also include an internal “black box” for field service forensics and diagnostics. The black box shall be capable of internal waveform capture with pre- and post- trigger memory in order to aid in trouble shooting and forensics of on-site service issues and events.

Q. External Interface
   1. The UPS shall have 6 [optional 18] alarm contacts for remote signaling. UPS to provide wetting voltage for contacts from auxiliary power supply. These alarm contacts shall each be programmable with any of the following signals:
      a. No information
      b. Audible alarm
      c. Summary alarm
      d. Load on utility
      e. Stop operation
      f. Load on inverter
      g. Utility failure
      h. DC over voltage
      i. Low battery
      j. Overload
      k. Over temperature
      l. Inverter not synched
      m. Bypass locked
      n. Bypass utility failure
      o. Rectifier utility failure
      p. Battery discharge
      q. Manual bypass on
      r. Rectifier on
      s. Inverter on
      t. Equalize boost charge
      u. Battery ground fault
      v. Battery fault
      w. eBoost/IEMi mode on
      x. User input 1
      y. User input 2
   2. Programming of the alarm contacts requires access with the appropriate password. The alarm contacts shall be accessible through standard form “C” wiring terminal block.
   3. The UPS shall have two programmable inputs for connection to external contact closures. The status of these external contacts can be monitored from the front panel of the UPS. The default configuration for these external signals shall be as follows:
      a. Aux. Input No. 1/’On Generator’
      b. Aux. Input No. 2/not defined remote shut down function shall allow the user to disable all UPS (Modules) outputs in an emergency situation via EPO. The Remote shut down shall be able to interface with normally closed (N.C.) systems.

R. Remote shut down
   1. The remote shut down function shall allow the user to disable all UPS (Modules) outputs in an emergency situation via EPO. The Remote shut down shall be able to interface with

normally closed (N.C.) systems. The Remote shut down shall be activated when a pair of contacts, external to the UPS, are activated. The Remote shut down connection shall be through a simple terminal block type connector.

S. Generator-on contact
   1. The 'On Generator' signal shall be used to optimize operation of the UPS while AC power is being supplied from an engine-generator. The following parameters shall be programmable in this mode:
      a. Inverter synchronization with generator (enable/disable). This parameter (disabled) shall protect the critical load from all frequency transients associated with engine-generator operation.
      b. Static bypass to generator (enable/disable). This parameter shall allow the user to prevent transfer of the critical load directly to the output of the engine-generator.
      c. Inverter output frequency slew-rate. This parameter shall allow the user to specify the maximum frequency rate-of-change when the inverter is phase-locked to an engine-generator. Adjustment range shall be 0.1 to 20.0 Hz/second, in 0.1 increments. This adjustment shall be independent of normal operation slew-rate.
      d. Recharge capability (enable/disable/delay). This parameter shall allow the user to select whether or not, and/or when the battery will be recharged while the UPS is powered from an engine-generator. This parameter shall be programmable directly in minutes, with zero disabling battery charging. This will conserve fuel and allow closer sizing of the engine-generator. The UPS rectifier shall also include a soft-start circuit to limit inrush current and apply load to the engine-generator gradually. Or stagger rectifier start times in order to gradually step multiple UPS's onto the generator in case of transfer to emergency generator after a utility failure.

**2.10 COMMUNICATIONS**

A. The UPS shall allow for flexibility in communications. The UPS shall be able to communicate through two communications ports simultaneously; the media of either communications port may change without affecting the operation of the UPS. The use of relay contacts shall not affect the operation of the two communications ports.

B. RS-232/RJ45 port
   1. The UPS shall provide at least one RS-232 port, allowing full remote monitoring, control and management of the UPS system. All access to control functions through this port shall be protected from unauthorized access.
   2. The RS-232 port shall allow access to critical UPS measurements, functions and historical data through the UPS Management Software suite.

C. Connectivity slot
   1. The UPS shall be equipped with Connectivity slot(s) allowing the installation of the following plug-in options:
      a. Additional Customer Interface Card (CIC) option, providing: six alarm contacts for remote signaling, two inputs for connection of external contact closures and one RS-232 port.
      b. SNMP/Web adapter option, providing the following functionalities over an Ethernet connection:
      c. SNMP Agent for integration into SNMP-based Network Management Systems (NMS)
      d. Web server for remote monitoring using a standard Web browser
      e. Modbus TCP or 485 slave for integration into Modbus-based Building Management Systems (BMS)
      f. Configurable alarm notification via e-mail or SNMP Traps
      g. Network shutdown of controlled servers following prolonged power outages via UPS Management Software suite.

D. Remote monitoring and diagnostics

1. UPS shall have a secure TCP/IP based RMD feature available as an option. Activation of this feature is standard and no charge for the first 12months. The feature provides remote monitoring and diagnostics via an in house 24x7 service team, and provides quarterly diagnostics reports, alarm history and power quality trending of the UPS

**2.11 BATTERY**

A. External Battery Cabinets (VRLA) Redundant
   1. Battery cabinet shall be in a NEMA Type 1 enclosure with front access only. The battery cabinet shall feature valve regulated lead-acid batteries which provide energy to the support the critical load during a momentary loss of input power to the rectifier. The connections between the UPS and the extended battery cabinets shall contain DC power only. Each battery cabinet must include its own DC breaker to allow isolation with 24VUVR, and A/B aux contacts.

**2.12 MAINTENANCE BYPASS/ISOLATION SWITCH**

A. Maintenance Bypass Cabinet (Single Module)
   1. Maintenance bypass shall be provided to isolate the UPS output, including, but not limited to, the module static switch, for maintenance. The maintenance bypass shall be interlocked with the UPS module to protect the system from damage in the event of out of service phase transfer. The maintenance bypass shall be housed in a separate free-standing enclosure and include a 480 – 208/120-3-60 Step-down Isolation Transformer.

**2.13 SOURCE QUALITY CONTROL**

A. Factory test complete UPS system before shipment. Use actual batteries that are part of final installation. 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 choice.

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.

**PART 3 EXECUTION**

**3.01 EXAMINATION**

A. Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the UPS.
   1. Verify that UPS modules are ready to install.
   2. Verify that required utilities are available, in proper location and ready for use.
   3. Inspect equipment for signs of shipping or installation damage.
   4. Verify installation per drawings and installation manuals.
   5. Inspect cabinets for foreign objects.
   6. Verify neutral and ground conductors are properly sized and configured.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.02 INSTALLATION

A. Equipment Mounting: Install UPS on concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

C. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.

## 3.03 GROUNDING

A. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer.

## 3.04 IDENTIFICATION

A. Identify components and wiring according to Division 26 Section "Identification for Electrical Systems."
   1. Identify each battery cell individually.

## 3.05 BATTERY EQUALIZATION

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

## 3.06 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
   1. Comply with manufacturer's written instructions.
   2. Inspect interiors of enclosures, including the following:
      a. Integrity of mechanical and electrical connections.
      b. Component type and labeling verification.
      c. Ratings of installed components.
   3. Inspect batteries and chargers according to requirements in NETA Acceptance Testing Specifications.
   4. Test manual and automatic operational features and system protective and alarm functions.
   5. Test communication of status and alarms to remote monitoring equipment.
   6. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated within the previous six months according to NIST standards.
      a. Simulate malfunctions to verify protective device operation.
      b. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
      c. Test harmonic content of input and output current less than 25, 50, and 100 percent of rated loads.

d. Test output voltage under specified transient-load conditions.
e. Test efficiency at 50, 75, and 100 percent of rated loads.
f. Test remote status and alarm panel functions.
g. Test battery-monitoring system functions.

D. The UPS system will be considered defective if it does not pass tests and inspections.

E. 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.

F. Prepare test and inspection reports.

**3.07 PERFORMANCE TESTING**

A. Engage the services of a qualified power quality specialist to perform tests and activities indicated.

B. Monitoring and Testing Schedule: Perform monitoring and testing in a single 10-day period.
1. Schedule monitoring and testing activity with Owner, through Architect, with at least 14 days' advance notice.
2. Schedule monitoring and testing after Substantial Completion, when the UPS is supplying power to its intended load.

C. Monitoring and Testing Instruments: Three-phase, recording, power monitors. Instruments shall provide continuous simultaneous monitoring of electrical parameters at UPS input terminals and at input terminals of loads served by the UPS. Instruments shall monitor, measure, and graph voltage current and frequency simultaneously and provide full-graphic recordings of the values of those parameters before and during power-line disturbances that cause the values to deviate from normal beyond the adjustable threshold values. Instruments shall be capable of recording either on paper or on magnetic media and have a minimum accuracy of plus or minus 2 percent for electrical parameters. Parameters to be monitored include the following:
1. Current: Each phase and neutral and grounding conductors.
2. Voltage: Phase to phase, phase to neutral, phase to ground, and neutral to ground.
3. Frequency transients.
4. Voltage swells and sags.
5. Voltage Impulses: Phase to phase, phase to neutral, phase to ground, and neutral to ground.
6. High-frequency noise.
7. Radio-frequency interference.
8. THD of the above currents and voltages.
9. Harmonic content of currents and voltages above.

D. Monitoring and Testing Procedures:
1. Exploratory Period: For the first two days, make recordings at various circuit locations and with various parameter-threshold and sampling-interval settings. Make these measurements with the objective of identifying optimum UPS, power system, load, and instrumentation setup conditions for subsequent test and monitoring operations.
2. Remainder of Test Period: Perform continuous monitoring of at least two circuit locations selected on the basis of data obtained during exploratory period.
a. Set thresholds and sampling intervals for recording data at values selected to optimize data on performance of the UPS for values indicated, and to highlight the need to adjust, repair, or modify the UPS, distribution system, or load component that may influence its performance or that may require better power quality.
b. Perform load and UPS power source switching and operate the UPS on generator power during portions of test period according to directions of Owner's power quality specialist.
c. Operate the UPS and its loads in each mode of operation permitted by UPS controls and by the power distribution system design.

d. Using loads and devices available as part of the facility's installed systems and equipment[ and a temporarily connected portable generator set], create and simulate unusual operating conditions, including outages, voltage swells and sags, and voltage, current, and frequency transients. Maintain normal operating loads in operation on system to maximum extent possible during tests.
e. Using temporarily connected resistive/inductive load banks[ and a temporarily connected portable generator set], create and simulate unusual operating conditions, including outages, voltage swells and sags, and voltage, current, and frequency transients. Maintain normal operating loads in operation on system to maximum extent possible during tests.
f. Make adjustments and repairs to UPS, distribution, and load equipment to correct deficiencies disclosed by monitoring and testing and repeat appropriate monitoring and testing to verify success of corrective action.

E. Coordination with Specified UPS Monitoring Functions: Obtain printouts of built-in monitoring functions specified for the UPS and its components in this Section that are simultaneously recorded with portable instruments in this article.
1. Provide the temporary use of an appropriate PC and printer equipped with required connections and software for recording and printing if such units are not available on-site.
2. Coordinate printouts with recordings for monitoring performed according to this article, and resolve and report any anomalies in and discrepancies between the two sets of records.

F. Monitoring and Testing Assistance by Contractor:
1. Open UPS and electrical distribution and load equipment and wiring enclosures to make monitoring and testing points accessible for temporary monitoring probe and sensor placement and removal as requested.
2. Observe monitoring and testing operations; ensure that UPS and distribution and load equipment warranties are not compromised.
3. Perform switching and control of various UPS units, electrical distribution systems, and load components as directed by power quality specialist. Specialist shall design this portion of monitoring and testing operations to expose the UPS to various operating environments, conditions, and events while response is observed, electrical parameters are monitored, and system and equipment deficiencies are identified.
4. Make repairs and adjustments to the UPS and to electrical distribution system and load components, and retest and repeat monitoring as needed to verify validity of results and correction of deficiencies.
5. Engage the services of the UPS manufacturer's factory-authorized service representative periodically during performance testing operations for repairs, adjustments, and consultations.

G. Documentation: Record test point and sensor locations, instrument settings, and circuit and load conditions for each monitoring summary and power disturbance recording. Coordinate simultaneous recordings made on UPS input and load circuits.

H. Analysis of Recorded Data and Report: Review and analyze test observations and recorded data and submit a detailed written report. Include the following in report:
1. Description of corrective actions performed during monitoring and survey work and their results.
2. Recommendations for further action to provide optimum performance by the UPS and appropriate power quality for non-UPS loads. Include a statement of priority ranking and a cost estimate for each recommendation that involves system or equipment revisions.
3. Copies of monitoring summary graphics and graphics illustrating harmonic content of significant voltages and currents.
4. Copies of graphics of power disturbance recordings that illustrate findings, conclusions, and recommendations.
5. Recommendations for operating, adjusting, or revising UPS controls.
6. Recommendation for alterations to the UPS installation.

7. Recommendations for adjusting or revising generator-set or automatic transfer switch installations or their controls.
8. Recommendations for power distribution system revisions.
9. Recommendations for adjusting or revising electrical loads, their connections, or controls.

I. Interim and Final Reports: Provide an interim report at the end of each test period and a final comprehensive report at the end of final test and analysis period.

**3.08 DEMONSTRATION**

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the UPS.

**END OF SECTION**

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