PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Three-phase, on-line, double-conversion, static-type, UPS units with the following features:
   a. Surge suppression.
   b. Rectifier-charger.
   c. Inverter.
   d. Static bypass transfer switch.
   e. Battery and battery disconnect device.
   f. Battery monitoring.

1.2 SUBMITTALS

A. Product Data: For each UPS component indicated.

B. Shop Drawings: Detail assemblies of equipment indicating dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.

1. Include wiring diagrams.

C. Factory test reports.

D. Field quality-control test reports.

E. Operation and maintenance data.

F. Warranties.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use and for compliance with the following:

1. UL 1778.
2. Suitable for installation in computer rooms according to NFPA 75.
1.4 WARRANTY

A. Special Battery Warranties: Specified form in which manufacturer and Installer agree to repair or replace UPS system storage batteries that fail in materials or workmanship within specified warranty period.

1. Warranted Cycle Life for Valve-Regulated, Lead-Acid Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F (25 deg C):

<table>
<thead>
<tr>
<th>Discharge Rate</th>
<th>Discharge Duration</th>
<th>Discharge End Voltage</th>
<th>Cycle Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 hours</td>
<td>8 hours</td>
<td>1.67</td>
<td>6 cycles</td>
</tr>
<tr>
<td>30 minutes</td>
<td>30 minutes</td>
<td>1.67</td>
<td>20 cycles</td>
</tr>
<tr>
<td>15 minutes</td>
<td>45 seconds</td>
<td>1.67</td>
<td>120 cycles</td>
</tr>
</tbody>
</table>

2. Warranted Cycle Life for Premium Valve-Regulated, Lead-Acid Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F (25 deg C):

<table>
<thead>
<tr>
<th>Discharge Rate</th>
<th>Discharge Duration</th>
<th>Discharge End Voltage</th>
<th>Cycle Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 hours</td>
<td>8 hours</td>
<td>1.67</td>
<td>40 cycles</td>
</tr>
<tr>
<td>30 minutes</td>
<td>30 minutes</td>
<td>1.67</td>
<td>125 cycles</td>
</tr>
<tr>
<td>15 minutes</td>
<td>1.5 minutes</td>
<td>1.67</td>
<td>750 cycles</td>
</tr>
</tbody>
</table>

B. Special UPS Warranties: Specified form in which manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within special warranty period.

1. Special Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OPERATIONAL REQUIREMENTS

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 normal ac supply circuit 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 among the three conditions in subparagraphs below 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.

D. 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. Ambient Temperature for Electronic Components: 32 to 104 deg F (0 to 40 deg C).
2. Ambient Temperature for Battery: 41 to 95 deg F (5 to 35 deg C).
3. Relative Humidity: 0 to 95 percent, noncondensing.

2.2 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 or minus 10 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.
5. Load is [30] [50] [100] percent unbalanced continuously.

B. Minimum Duration of Supply: If battery is sole energy source supplying rated full UPS load current at 80 percent power factor, duration of supply is [5] [10] [15] <Insert duration> minutes.


D. Overall UPS Efficiency: Equal to or greater than <Insert number> percent at 100 percent load, <Insert number> percent at 75 percent load, and <Insert number> percent at 50 percent load.

E. Maximum Acoustical Noise: <Insert value,> "A" weighting, emanating from any UPS component under any condition of normal operation, measured 39 inches (990 mm) <Insert distance> from nearest surface of component enclosure.

F. Maximum Energizing Inrush Current: [Six] [Eight] times the full-load current.

G. Maximum AC Output-Voltage Regulation for Loads up to 50 Percent Unbalanced: Plus or minus 2 percent over the full range of battery voltage.

H. Output Frequency: 60 Hz, plus or minus 0.5 percent over the full range of input voltage, load, and battery voltage.

I. Limitation of harmonic distortion of input current to the UPS shall be as follows:
1. **Description:** Either a tuned harmonic filter or an arrangement of rectifier-charger circuits shall limit THD to \([5][10]\) percent, maximum, at rated full UPS load current, for power sources with X/R ratio between 2 and 30.

J. **Maximum Harmonic Content of Output-Voltage Waveform:** 5 percent RMS total and 3 percent RMS for any single harmonic, for rated full load with THD up to 50 percent, with a load crest factor of 3.0.

K. **Minimum Overload Capacity of UPS at Rated Voltage:** 125 percent of rated full load for 10 minutes, and 150 percent for 30 seconds in all operating modes.

L. **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 5 percent.
   3. Loss of AC Input Power: Plus or minus 1 percent.
   4. Restoration of AC Input Power: Plus or minus 1 percent.

M. **Input Power Factor:** A minimum of \([0.70][0.85]\) lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current.

N. **EMI Emissions:** Comply with FCC Rules and Regulations, and with 47 CFR 15 for Class A equipment.

### 2.3 UPS SYSTEMS

A. **Manufacturers:**

   1. Liebert Corporation; a division of Emerson.
   2. APC.
   3. Powerware Division of Eaton Corp.

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:** Comply with NEMA 250, Type 1, unless otherwise indicated.

D. **Control Assemblies:** Mount on modular plug-ins, readily accessible for maintenance.

E. **Surge Suppression:** Protect internal UPS components from surges that enter at each ac power input connection including main disconnect switch and static bypass transfer switch. Protect rectifier-charger, inverter, controls, and output components.

   1. Use factory-installed surge suppressors tested according to IEEE C62.41, Category \([B][C]\).
F. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.

2.4 RECTIFIER-CHARGER

A. 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.

B. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.

C. Rectifier-Charger Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.

   1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.

D. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life.

2.5 INVERTER

A. Description: Pulse-width modulated, with sinusoidal output.

2.6 STATIC BYPASS TRANSFER SWITCH

A. Description: Solid-state switching device providing uninterrupted transfer. A contactor or electrically operated circuit breaker automatically provides electrical isolation for the switch.

B. Switch Rating: Continuous duty at the rated full UPS load current, minimum.

2.7 BATTERY

A. Description: Valve-regulated, premium, heavy-duty, recombinant, lead-calcium units, factory assembled in an isolated compartment or in a separate matching cabinet, complete with battery disconnect switch.

   1. Manufacturers:

      a. EnerSys, Inc.
      b. Powerware Division of Eaton Corporation.
      c. C&D Technologies, Inc.; standby Power Division
2.8 CONTROLS AND INDICATIONS

A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.

B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.

C. Indications: [Labeled LED] [Plain-language messages on a digital LCD or LED].

1. Quantitative indications shall include the following:
   a. Input voltage, each phase, line to line.
   b. Input current, each phase, line to line.
   c. Bypass input voltage, each phase, line to line.
   d. Bypass input frequency.
   e. System output voltage, each phase, line to line.
   f. System output current, each phase.
   g. System output frequency.
   h. DC bus voltage.
   i. Battery current and direction (charge/discharge).
   j. Elapsed time discharging battery.

2. Basic status condition indications shall include the following:
   a. Normal operation.
   b. Load-on bypass.
   c. Load-on battery.
   d. Inverter off.
   e. Alarm condition.

3. Alarm indications shall include the following:
   a. Bypass ac input overvoltage or undervoltage.
   b. Bypass ac input overfrequency or underfrequency.
   c. Bypass ac input and inverter out of synchronization.
   d. Bypass ac input wrong-phase rotation.
   e. Bypass ac input single-phase condition.
   f. Bypass ac input filter fuse blown.
   g. Internal frequency standard in use.
   h. Battery system alarm.
   i. Control power failure.
   j. Fan failure.
   k. UPS overload.
   l. Battery-charging control faulty.
   m. Input overvoltage or undervoltage.
n. Input transformer overtemperature.
o. Input circuit breaker tripped.
p. Input wrong-phase rotation.
q. Input single-phase condition.
r. Approaching end of battery operation.
s. Battery undervoltage shutdown.
t. Maximum battery voltage.
u. Inverter fuse blown.
v. Inverter transformer overtemperature.
w. Inverter overtemperature.
x. Static bypass transfer switch overtemperature.
y. Inverter power supply fault.
z. Inverter transistors out of saturation.
aa. Identification of faulty inverter section/leg.
bb. Inverter output overvoltage or undervoltage.
c. UPS overload shutdown.
d d. Inverter current sensor fault.
e e. Inverter output contactor open.
ff. Inverter current limit.

4. Controls shall include the following:
   a. Inverter on-off.
   b. UPS start.
   c. Battery test.
   d. Alarm silence/reset.
   e. Output-voltage adjustment.

D. Emergency Power Off Switch: Capable of local operation and operation by means of activation by external dry contacts.

E. Manufacturers:
   1. BTECH Inc.
   2. Albercorp
   3. Powerware Division of Eaton Corporation.

F. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.

G. Annunciation of Alarms: At UPS control panel.

2.9 BATTERY-CYCLE WARRANTY MONITORING

A. Description: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring of charge-discharge cycle history of batteries covered by cycle-life warranties.
B. Performance: Automatically measures and records each discharge event, classifies it according to duration category, and totals discharges according to warranty criteria, displaying remaining warranted battery life on front panel display.

2.10 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.
4. Overload test.
5. Power failure test.

B. Report test results.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install system components on 4-inch- (100-mm-) high concrete bases. Concrete base construction requirements are specified in Division 16 Section "Electrical Supports and Seismic Restraints."

B. Maintain minimum 36” clearance on all (4) four sides and the top to allow for disassembly and servicing.

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

D. 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.

E. Identify components and wiring according to Division 26 Section "Electrical Identification."

F. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.
3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust equipment installation including connections, and to assist in field testing. Report results in writing.

B. Electrical Tests and Inspections: Perform tests and inspections according to manufacturer's written instructions and as listed below to demonstrate condition and performance of each UPS component:

1. 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.

2. Test manual and automatic operational features and system protective and alarm functions.

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.

3.3 TRAINING

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 "Closeout Procedures."

END OF SECTION