

# **Schneider Electric**

## **Easy UPS 3S 3:1**

### **Data Center Grade Three Phase Uninterruptible Power Supply 3×400 V UPS - Guide Specifications 10 kVA to 30 kVA UPS**

*THIS GUIDE SPECIFICATION IS WRITTEN IN ACCORDANCE WITH THE CONSTRUCTION SPECIFICATIONS INSTITUTE (CSI) MASTERFORMAT. THIS SECTION MUST BE CAREFULLY REVIEWED AND EDITED BY THE ARCHITECT OR THE ENGINEER TO MEET THE REQUIREMENTS OF THE PROJECT. COORDINATE THIS SECTION WITH OTHER SPECIFICATION SECTIONS IN THE PROJECT MANUAL AND WITH THE DRAWINGS.*

*WHERE REFERENCE IS MADE THROUGHOUT THIS SECTION TO "PROVIDE", "INSTALL", "SUBMIT", ETC., IT SHALL MEAN THAT THE CONTRACTOR, SUBCONTRACTOR, OR CONTRACTOR OF LOWER TIER SHALL "PROVIDE", "INSTALL", "SUBMIT", ETC., UNLESS OTHERWISE INDICATED.*

*THIS SECTION IS WRITTEN TO INCLUDE THE 2004 MASTERFORMAT AND THE 1995 MASTERFORMAT VERSIONS. WHERE APPLICABLE, THESE ITEMS ARE BRACKETED AND, IN EACH CASE, UNLESS OTHERWISE INDICATED, THE FIRST CHOICE APPLIES TO THE 2004 MASTERFORMAT AND THE SECOND CHOICE APPLIES TO THE 1995 MASTERFORMAT.*

## **SECTION [26 33 63] [16611]**

### **SOLID STATE UNINTERRUPTIBLE POWER SUPPLY**

#### **Part 1 GENERAL**

##### **1.1. Related documents**

- A. Drawings and general provisions of the Contract, including General Conditions, [Division 01 GENERAL REQUIREMENTS] [Division 1 GENERAL REQUIREMENTS], and other applicable specification sections in the Project Manual apply to the work specified in this Section.

##### **1.2. Summary**

- A. **Scope:** Provide design and engineering, labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for a solid state uninterruptible power supply (UPS) as required for the complete performance of the work, and as shown on the Drawings and as herein specified.
- B. **Section includes:** This specification describes a three-phase, on-line, continuous operation, solid-state uninterruptible power supply (UPS). The UPS shall operate as an active power control system, working in conjunction with the building electrical system to provide power conditioning and on-line power protection for the critical loads.

##### **1.3. System description**

- A. The UPS shall consist of easy to repair rectifiers/inverters.
- B. The UPS shall be provided with separate feeds for rectifier/inverter and the static bypass switch.
- C. Modes of operation: The UPS shall operate as an on-line system in the following modes:
  - 1. Normal mode: The inverter and the rectifier shall operate in an on-line manner to continuously regulate the power to the critical load. The rectifier shall derive power from the input source and supply DC power to charge the battery.
  - 2. Battery mode: Upon failure of the input source, the load shall continue being supplied by the inverter without any switching. The inverter shall obtain its power from the battery. There shall be no interruption in power to the load upon failure or restoration of the input source.
  - 3. Frequency converter mode: The output frequency will be fixed to 50 Hz or 60 Hz.

4. **Battery recharge:** Upon restoration of the input source, the UPS shall simultaneously recharge the battery and regulate the power to the load.
  5. **Static bypass mode:** The static bypass switch shall be used for transferring the load to bypass supply without interruption. Re-transfer to normal operation shall also be accomplished with no interruption in power to the load.
  6. **ECO mode:** In ECO mode, the UPS shall use static bypass mode as the preferred operation mode under predefined conditions. In case of a failure of the input source, the UPS shall transfer to battery mode.
  7. **Maintenance bypass mode:** The UPS shall be provided with a maintenance bypass breaker (MBB) to supply the load directly from the mains supply.
  8. **Auto-restart mode:** When the UPS is configured to auto-restart, the UPS shall automatically restart after end of discharge and restoration of the input source.
- D. The UPS shall be provided with RS232, RS485, USB, and dry contact signaling and WEB/SNMP integration. This system must provide a means for logging and alarming of all monitored points.

#### 1.4. References

- A. **General:** The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
- B. **International Organization for Standardization (ISO):**
1. ISO 9001, "Quality Management Systems Requirements."

#### 1.5. Standards

- A. **Safety:**
1. IEC 62040-1: 2008-06, 1st edition Uninterruptible Power Systems (UPS) - Part 1: General and safety requirements for UPS
  2. EN 62040-1: 2013-01, 1st edition amendment 1
- B. **EMC/EMI/RFI:** IEC 62040-2: 2005-10, 2nd edition Uninterruptible Power Systems (UPS) - Part 2: Electromagnetic compatibility (EMC) requirements
- C. **Performance:** IEC 62040-3: 2011-03, 2nd edition Uninterruptible Power Systems (UPS) - Part 3: Method of specifying the performance and test requirements
- D. **Environmental:** IEC 62040-4: 2013-04, 1st edition Uninterruptible Power Systems (UPS) - Part 4: Environmental aspects – Requirements and reporting

#### 1.6. Submittals

- A. **Proposal Submittals**
1. System bill of materials (level one)
  2. Product technical specifications or equipment brochures
  3. Product specifications
  4. System operation diagram
  5. Installation guide
  6. Drawings for requested optional accessories
- B. **Delivery Submittals**
1. Installation manual, which includes unpacking and installation of all systems.
  2. Operation manual, which includes start-up and operating instructions.

## 1.7. Quality assurance

### A. Qualifications

1. **Manufacturer experience:** The manufacturer shall have a minimum of 20 years experience in the design, manufacture, and testing of UPS systems.
2. **ISO 9001 Certification:** The manufacturer shall be ISO 9001 & 14001 certified. Certification assures that the vendor's quality control & environmental measures have been certified by an accredited registrar and meet internationally recognized standards.
3. **Installer Qualifications:** Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing solid state UPS similar in type and scope to that required for this Project.

### B. Regulatory requirements

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

### C. Factory testing

Prior to shipment the manufacturer shall complete a documented test procedure to test functions of the UPS module and batteries (via a discharge test), when supplied by the UPS manufacturer, and warrant compliance with this Section.

### D. Pre-installation conference

Conduct pre-installation conference in accordance with [Section 01 31 19 PROJECT MEETINGS] [Section 01200 PROJECT MEETINGS]. Prior to commencing the installation, meet at the Project site to review the material selections, installation procedures, and coordination with other trades. Pre-installation conference shall include, but shall not be limited to, the Contractor, the Installer, and any trade that requires coordination with the work. Date and time of the pre-installation conference shall be acceptable to the Owner and the Architect/Engineer.

### E. Source responsibility

Materials and parts comprising the UPS shall be new, of current manufacture, and shall not have been in prior service, except as required during factory testing. Active electronic devices shall be solid state and shall not exceed the manufacturer's recommended tolerances for temperature or current to ensure maximum reliability. Semiconductor devices shall be sealed. Relays shall be provided with dust covers. The manufacturer shall conduct inspections on incoming parts, modular assemblies, and final products.

## 1.8. Delivery, storage, and handling

- A. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and lot number, if any.
- B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
- C. Products shall be packaged in a manner to prevent penetration by debris and to allow safe delivery by modes of ground transportation and air transportation where specified.
- D. Prior to shipping, products shall be inspected at the factory for damage.
- E. Equipment shall be protected against extreme temperature and humidity and shall be stored in a conditioned or protected environment.
- F. Equipment containing batteries shall not be stored for a period exceeding three months without powering up the equipment for a period of eight hours to recharge the batteries.

## 1.9. Project conditions

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

A. **Environmental requirements**

1. Storage ambient temperature: -25 °C to 55 °C (UPS), -15 °C to 40 °C (for UPS with internal batteries).
2. Operating ambient temperature: 0 °C to 40 °C for batteries and UPS.
3. Relative humidity: 0 to 95%, non-condensing.
4. Storage altitude: 0 to 15000 m above sea level.
5. Operating altitude with no derating: 0 to 1000 m above sea level.

1.10. **Warranty**

A. **General:** See [Section 01 77 00 - CLOSEOUT PROCEDURES]  
[Section 01770 - CLOSEOUT PROCEDURES].

B. **Special Warranty:** The Contractor shall warrant the work of this Section to be in accordance with the Contract Documents and free from faults and defects in materials and workmanship for period indicated below. This special warranty shall extend the one year period of limitations contained in the General Conditions. The special warranty shall be countersigned by the Installer and the manufacturer.

1. **UPS:** The UPS shall be covered by a full parts and labor warranty from the manufacturer for a period of 12 months from date of installation or acceptance by the Owner or 18 months from date of shipment from the manufacturer, whichever occurs first.
2. **Battery:** The battery manufacturer's warranty shall be passed through to the final Owner and shall have a minimum period of one year.

C. **Additional Owner Rights:** The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

1.11. **Maintenance**

- A. The manufacturer shall, upon request, provide spare parts kits for the UPS module in a timely manner as well as provide access to qualified and trained service personnel to provide preventative maintenance and service on the UPS module when required.
- B. A self-test function shall identify the subassembly requiring repair in the event of an alarm condition. The electronic UPS control and monitoring assembly shall therefore be fully microprocessor-based, thus doing away with potentiometer settings. This shall allow:
  1. Auto-compensation of component drift.
  2. Self-adjustment of replaced subassemblies.
  3. Extensive acquisition of information vital for computer-aided diagnostics (local or remote).
  4. Socket connection to interface with computer-aided diagnostics system.
- C. The UPS shall be repairable by replacing standard subassemblies requiring no adjustments.
- D. The manufacturer shall offer additional preventative maintenance and service contracts covering both the UPS and the batteries. Accredited professional service representatives employed exclusively in the field of critical power systems service shall perform maintenance and service. The manufacturer shall also offer extended warranty contracts.

## Part 2 PRODUCT

### 2.1. Manufacturer

A. **Schneider Electric:** Easy UPS 3S. No substitutes will be considered.

OR

B. **Schneider Electric:** Easy UPS 3S or approved equal. However, if a brand other than Schneider is proposed, the decision of the Engineer shall be final and a "differentiation report" must be submitted. This report shall address each paragraph of the specification individually and list any difference from what is specified. If there are no differences, a report stating so shall be provided. If, after installation, omitted differences are found, the Contractor shall correct differences to the satisfaction of the Owner and Engineer or unsatisfactory equipment shall be removed and equipment acceptable to the Owner and Engineer shall be installed at no additional cost to the project. Also, make modifications to the facilities infrastructure as needed to accommodate the substitute, at no additional cost to the project. Examples of modifications include, but are not limited to the following:

1. Structural reinforcement to accommodate heavier equipment.
2. Increased sizes of circuit breakers, raceways and wiring.
3. Larger back-up generators (including upgraded accessories and wiring) to avoid instability caused by most double conversion UPS systems.
4. Larger HVAC equipment (including duct work and wiring) to accommodate increased heat dissipation of less efficient UPS systems.

### 2.2.

#### Static UPS

##### A. General

1. The UPS shall be housed in a freestanding cabinet with casters and shall contain the following breakers.
  - a. Unit input breaker (UIB)
  - b. Static switch input breaker (SSIB)
  - c. Unit output breaker (UOB)
  - d. Maintenance bypass breaker (MBB)
  - e. Battery breaker (BB) – only for UPS with internal batteries
2. Installation access shall be from the backside of the system.
3. The UPS shall be in a self-contained cabinet and shall be available in the following models: 10 kVA, 15 kVA, 20 kVA, and 30 kVA.
4. The UPS shall contain a bypass static switch; and a display. The UPS shall be of the double conversion on-line topology with power factor corrected inputs.
5. The UPS shall be sized for \_\_\_\_\_ kVA and \_\_\_\_\_ kW load.
6. The UPS battery shall be sized for \_\_\_\_\_ at a power factor of \_\_\_\_\_ for \_\_\_\_\_ minutes.
7. The UPS system shall have a runtime of \_\_\_\_\_ minutes.
8. The UPS shall have a short circuit withstand capability of 10 kA.
9. The UPS shall contain an EPO.

##### B. System input

1. Nominal Input voltage rating: 3x400 V (adjustable for 3x380 V or 3x 415 V).
2. Input voltage window: 304 V to 477 V.
3. Earthing principle: [TN-S] [TN-C] [TT] or [IT].
4. Input frequency range: 45-65 Hz
5. Input power factor: > 0.99
6. Total harmonic distortion:
  - a. < 3% at 10 kVA
  - b. <4% at 15-30 kVA

##### C. System output

1. Nominal output voltage rating: 230 V 3-phase.
2. Output voltage tolerance: +/- 1.5%

3. Dynamic load response: 40 ms.
4. Output frequency: 50 or 60 Hz.
5. Output voltage harmonic distortion:
  - a. <3% at 100% linear load.
  - b. <5.5% at 100% non-linear load.
6. Overload capability:
  - a. 110% for 60 minutes.
  - b. 125% for 10 minutes.
  - c. 150% for 1 minute.
  - d. > 150% for less than 200 milliseconds
7. Output power factor: 1.0.  
**Note:** For 20-30 kVA systems, when the ambient temperature is above 30 °C, the power factor is 0.9.
8. Efficiency in normal operation at 100% load:
  - a. 10 kVA: 94.4%
  - b. 15 kVA: 94.4%
  - c. 20 kVA: 95.0%
  - d. 30 kVA: 94.7%
9. Audible noise at full load:
  - a. 10-20 kVA ≤ 60 dBA
  - b. 30-40 kVA ≤ 63 dBA

#### D. Components

1. Rectifier
  - a. The UPS shall include an active power factor corrected, Insulated Gated Bipolar Transistor (IGBT) rectifier.
  - b. The input current limiter shall be designed to:
    - 1) support 150% load at 304 V input voltage
    - 2) charge batteries at 20% of the UPS output rating
    - 3) provide regulation with mains deviation of up/down to ±15% of the nominal input voltage.
  - c. DC bus voltage shall be ± 360/380/400 VDC for the input voltages 380/400/415 V.
  - d. The battery charging shall keep the float voltage of ± 216 VDC to ± 270 VDC for 16-20 blocks.
  - e. The battery charging voltage shall be compensated against temperature variations (battery temperature compensation) to always maintain optimal battery float charging. Temperature compensation rate shall be 3mV/degree/cell for ambient temperatures > 25°C and 0mV/°C for ambient temperatures < 25°C.
  - f. Input power factor shall be 0.98 lagging at 100% load with out the use of passive filters. Rectifier shall employ electronic waveform control technology to maintain the current sinusoidal.
  - g. Pulse Width Modulation (PWM) current control shall be used. Digital Signal Processors (DSP) shall be used for all monitoring and control tasks. Analog control is not acceptable.
2. Batteries
  - a. Standard battery technology shall be sealed lead acid.
  - b. Battery voltage shall be battery temperature compensated as outlined in the rectifier section above.
  - c. End of discharge voltage at full load: ± 158 VDC to ± 198 VDC for 16-20 blocks.
  - d. Battery charge current limit: The selection shall be made from the UPS Soft Tuner. The battery charge current limit should be software and hardware current limit.
  - e. The battery charging circuit shall remain active when the PFC operates normally.
3. Inverter
  - a. The inverter shall consist of fast switching IGBT modules.

- b. The inverter shall be a 3-level inverter.
  - c. Inverter shall be PWM controlled using DSP logic. Analog control shall not be acceptable.
  - d. The inverter modules shall be rated for an output power factor at 1.0.
  - e. Nominal output voltage shall be 3x230 V (adjustable for 3x220 V or 3x240 V).
4. Static bypass switch
- a. The static switch shall consist of fully rated Silicon Controlled Rectifiers (SCRs). Part rated SCRs with a wrap around contactor are not acceptable.
  - b. The static bypass switch shall automatically transfer the load to bypass input supply without interruption after the logic senses one of the following conditions:
    - 1) Inverter overload beyond rating.
    - 2) Battery runtime expired and bypass available.
    - 3) Inverter inoperable.
    - 4) Control system inoperable.
  - c. The static bypass switch shall automatically retransfer from bypass to the inverter, when one of the following conditions occurs:
  - d. The inverter shall be active (on).
  - e. The static bypass switch shall be equipped with a manual means of transferring the load to bypass and back to inverter.

**E. Mechanical**

- 1. Easy UPS 3S is housed in a freestanding cabinet with casters.
- 2. The cable entry shall be from the back of the UPS.
- 3. The Easy UPS 3S has the following dimensions and shall meet an ingress level of minimum IP20.
  - a. UPSs for external batteries:
    - 1) 10 kVA UPS: 530x250x700 mm
    - 2) 15 kVA UPS: 530x250x700 mm
    - 3) 20 kVA UPS: 770x250x800 mm
    - 4) 30 kVA UPS: 770x250x800 mm
  - b. UPSs with internal batteries:
    - 1) 10 kVA UPS: 1400x380x907 mm
    - 2) 15 kVA UPS: 1400x380x907 mm
    - 3) 20 kVA UPS: 1400x380x907 mm
    - 4) 30 kVA UPS: 1400x500x996 mm

**F. Display, controls, and alarms**

- 1. A display unit shall be located on the front of the system. The display shall consist of an alphanumeric display with backlight, an alarm LED, and a keypad consisting of pushbutton switches.
- 2. The following metered data, shall be available on the alphanumeric display:
  - a. Year, month, day, hour, minute, second of occurring events
  - b. Input voltage
  - c. Input current
  - d. Input frequency
  - e. Output voltage
  - f. Output current
  - g. Output frequency
  - h. Battery voltage
  - i. Battery current
  - j. Battery temperature
- 3. The display shall allow the user to display active alarms.
- 4. The following controls or programming functions shall be accomplished by use of the display unit. Push button membrane switches shall facilitate these operations.
  - a. Silence audible Alarm
  - b. Set the alphanumeric display language
  - c. Display and set the date and time
  - d. Enable or disable the automatic restart feature
  - e. Transfer load to and from static bypass

- f. Test battery condition on demand
- 5. The following shall make up the UPS front panel LED's:
  - a. Load
    - 1) Green: UPS output is on.
    - 2) Red: Overload on UPS output for too long, or output has shorted, or no output power present.
    - 3) Flashing red: Overload on UPS output.
    - 4) Off: UPS output is off.
  - b. Battery
    - 1) Green: Battery is charging.
    - 2) Flashing green: Battery is discharging.
    - 3) Red: Battery is inoperable.
    - 4) Flashing red: Battery low voltage.
    - 5) OFF: Battery and battery charger are normal, battery is not charging.
  - c. Bypass
    - 1) Green: Load supplied by bypass source.
    - 2) Red: Bypass source is unavailable or static bypass switch is inoperable.
    - 3) Flashing red: Bypass voltage is out of tolerance.
    - 4) OFF: Bypass source is normal.
  - d. Rectifier
    - 1) Green: Rectifier is working correctly.
    - 2) Flashing green: Rectifier is working correctly and mains is normal.
    - 3) Red: Rectifier is inoperable.
    - 4) Flashing red: Mains is unavailable.
    - 5) OFF: Rectifier is off.
  - e. Inverter
    - 1) Green: Load supplied by inverter.
    - 2) Flashing green: Inverter on, start, synchronization or standby (ECO mode) for at least
    - 3) one module.
    - 4) Red: Load not supplied by inverter, inverter is inoperable.
    - 5) Flashing red: Load supplied by inverter, but an inverter alarm is present.
    - 6) OFF: Inverter is off.
  - f. Status
    - 1) Green: Normal mode.
    - 2) Red: Inoperable status.
- 6. Push Button User Controls
  - a. Home
  - b. Previous
  - c. Next
  - d. Confirm
- 7. For purposes of remote communications with the UPS an optional network management card shall be available.

**G. Accessories**

- 1. **Software and connectivity**
  - a. The Ethernet Web/SNMP Adaptor shall allow one or more network management systems (NMS) to monitor and manage the UPS in TCP/IP network environments. The management information base (MIB) shall be provided in .MIB formats. The SNMP interface adaptor shall be connected to the UPS via the RJ45 serial port on the standard communication interface board.
  - b. Unattended Shutdown.
- 2. **Remote UPS monitoring**

Three methods of remote UPS monitoring shall be available:

  - a. Web Monitoring: Remote monitoring shall be available via a web browser such as Internet Explorer.
  - b. Simple Network Management Protocol (SNMP): Remote UPS Monitoring shall be possible through a standard MIB II compliant platform.
  - c. Modbus protocol through RS485 port.



3. **Software compatibility**

The UPS manufacturer shall have available software to support shutdown and or remote monitoring for the following systems:

- a. Microsoft Windows 7

**Part 3 EXECUTION**

3.1. **Examination**

A. **Verification of conditions:** Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Architect/Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2. **Installation**

Preparation and installation shall be in accordance with reviewed product data, final shop drawings, manufacturer's written recommendations, and as indicated on the Drawings.

3.3. **Manufacturer assisted start-up**

A manufacturer assisted UPS start-up shall available, manufacturer trained service personnel shall perform the following inspections, test procedures, and on-site training:

A. **Visual Inspection**

1. Inspect equipment for signs of damage.
2. Verify installation per manufacturer's instructions.
3. Inspect cabinets for foreign objects.
4. Inspect batteries.
5. Inspect the PFC, the AC caps and DC caps.
6. Measure board voltages.

B. **Mechanical Inspection**

1. Check all UPS, external battery enclosures internal power wiring connections.
2. Check all UPS, external battery enclosures terminal screws, nuts, and/or spade lugs for tightness.

C. **Electrical Inspection**

1. Verify correct input and bypass voltage.
2. Verify correct phase rotation of all mains connections.
3. Verify correct UPS control wiring and terminations.
4. Verify voltage of batteries.
5. Verify neutral and ground conductors are properly landed.

D. **Site Testing**

1. Ensure proper system start-up.
2. Verify proper firmware control functions.
3. Verify proper firmware bypass operation.
4. Verify proper maintenance bypass switch operation.
5. Verify system set points.
6. Verify proper inverter operation and regulation circuits.
7. Simulate input power failure.
8. Verify proper charger operation
9. Document, sign, and date all test results.

E. **On-Site Operational Training:** During the manufacturer assisted start-up, operational training for site personnel shall include key pad operation, LED indicators, start-up and shutdown procedures, maintenance bypass and AC disconnect operation, and alarm information.

**3.4. Manufacturer field service**

- A. **Worldwide service:** The UPS manufacturer shall have a worldwide service organization. Available, consisting of factory trained field service personnel to perform start-up, preventative maintenance, and service of the UPS system and power equipment. The service organization shall offer 24 hours a day, 7 days a week, 365 days a year service support.

**3.5. Demonstration**

Provide the services of a manufacturer-authorized service representative of the manufacturer to provide start-up service and to demonstrate and train the Owner's personnel.

- A. Test and adjust controls and safety. Replace damaged or inoperable controls and equipment.
- B. Train the Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventive maintenance.
- C. Review data in operation manual with the Owner's personnel.

**3.6. Maintenance contracts**

A complete offering of preventative and full service maintenance contracts for the UPS system and the battery system shall be available. All contract work shall be performed by Schneider Electric trained service personnel.

**3.7. Training**

UPS service training workshop: A UPS service training workshop shall be available from the UPS manufacturer. The service training workshop shall include a combination of lecture and practical instruction with hands-on laboratory sessions. The service training workshop shall include instruction about safety procedures, UPS operational theory, sub-assembly identification and operation, system controls and adjustment, preventative maintenance, and troubleshooting.

**END OF SECTION**