

SCOPE OF WORK


**UNINTERRUPTIBLE POWER SUPPLY
MULTIPLE LOCATIONS**


**CHIEF ENGINEER INFRASTRUCTURE (CENI)
POWER**

July 21, 2016

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MULTIPLE LOCATIONS**

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POWER**

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1. Summary:

- A. The scope includes all work required to furnish 62.5kVA uninterruptible power supplies (UPSs) along with training and commissioning support. An example of an acceptable UPS is the Gutor type PDW.
- B. The contractor shall be responsible for furnishing and delivering the UPSs to the Farrington warehouse, located at 6100 Farrington Ave., Alexandria, VA. F.O.B. Destination.
- C. The UPSs shall be provided in accordance with the attached reference specification, Section 26 33 53.

2. References:

- A. Section 26 33 53. (Attachment 1)
- B. Single line drawing. (Attachment 2)

3. Work Tasks:

- A. Furnish and deliver 62.5kVA UPSs as ordered under the Indefinite Delivery Indefinite Quantity (IDIQ) contract. The initial order will be for six (6) UPSs. A First Article Inspection (FAI) is required. See Terms and Conditions – Chapter III, Clause 7 “First Article Inspection.”
- B. Provide training per Section 26 33 53 for a total of 15 engineers and technicians during the first shift (7AM – 3:30PM) for the initial order. Additional training sessions may be ordered as necessary.
- C. Provide commissioning support for all UPSs. Note that UPSs will be installed under a separate contract at a later time.

4. Deliverables:

In addition to the deliverables identified in Section 26 33 53, the following are also required:

- A. Commissioning details and procedures at least sixty (60) days prior to the first commissioning.
- B. Recommended spare parts list, quantities, and price breakdown to cover one (1) year of routine and unscheduled maintenance following the two (2) year warranty period. The spare parts list shall be provided with delivery of the first UPS.
- C. Manufacturing and delivery milestone schedule within thirty (30) days of Notice to Proceed (NTP).

5. Delivery Schedule:

The Contractor shall deliver all UPSs within 32 weeks of NTP. All deliveries shall be coordinated with the Contracting Officer’s Technical Representative (COTR).

6. Acceptance Criteria:

- A. Satisfactory “Factory Acceptance Testing” (FAT). The Contractor shall notify WMATA at least 3 weeks prior to FAT.
- B. Certified test report.
- C. Visual inspection that reveal no physical damages.

7. Commissioning:

- A. Initial energizing of each UPS shall be under the guidance of the manufacturer's representative who will advise Contractor and Authority personnel on step-by-step start-up procedures. Manufacturer’s representative shall be familiar with the installation, start-up and operation of the system and be capable of performing switching operations in accordance with all safety protocol.
- B. Commissioning of the equipment shall include but not be limited to:
 - i. Energizing and starting the UPS.
 - ii. Switching from normal to bypass operation.
 - iii. Switching from bypass to normal operation.
 - iv. Switching over to manual bypass.
 - v. Switching from bypass to normal operation.
 - vi. Isolating and de-energizing the UPS.

8. Warranty:

All workmanship, parts and materials furnished for this Contract shall be unconditionally warranted against failures or defects for a period of two (2) years after the Authority accepts them or places them in service, whichever is earlier. See Terms and Conditions – Chapter III, Clause 5 “Warranty”.

9. Responsibilities:

- A. The Contractor shall be responsible for day-to-day management of the Contract’s requirements and the assurance that the equipment delivered is in accordance with the Contract’s terms and conditions.
- B. The contractor shall provide the full resources necessary to complete the managerial, technical, administrative, audit and quality assurance/quality control tasks associated with the scope of work.

10. Reporting and Communication:

The Contractor shall provide information on an as needed basis to answer questions concerning interpretation of Contract documents, factory acceptance testing, training, and other operational concerns throughout the Contract.

11. Non-Disclosure Statement:

The use of WMATA documents shall not be disclosed without express written approval of the General Manager of the Authority.

End

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY



CHIEF ENGINEER INFRASTRUCTURE (CENI)

POWER

UNINTERRUPTIBLE POWER SUPPLY

Approved By:

Dwayne A. Kerr

7/22/2016

Dwayne A. Kerr, P.E.

Assistant Chief Engineer - Power

SECTION 26 33 53

UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing industrial grade integrated 62.5 kVA uninterruptible power supply (UPS), consisting of rectifier/charger, inverter and static transfer switch manufactured as a single enclosure/assembly. An example of an acceptable UPS is the Gutor type PDW.
- B. Related Work Specified Elsewhere:
 - 1. None.

1.02 QUALITY ASSURANCE:

- A. Comply with the following Codes, Regulations, Reference Standards and Specifications:
 - 1. Codes and regulations of jurisdictional authorities.
 - 2. National Electrical Code (NEC).
 - 3. National Electrical Manufacturers Association (NEMA) Standard: PE1, Uninterruptible Power Systems
 - 4. American National Standards Institute (ANSI): C39.1, Requirements, Electrical Analog Indicating Instruments; and Z55.1, Gray Finishes for Industrial Apparatus and Equipment.
 - 5. ANSI/NEMA Standards: PB1, Panelboards, and 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 6. ANSI/IEEE Standards: C57.12.90, Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers; 450, IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead- Acid Batteries for Stationary Applications, and 484, IEEE Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications.
 - 7. UL: 50, Enclosures for Electrical Equipment; 67, Panelboards; 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; and 198C, High-Interrupting-Capacity Fuses, Current Limiting Type, UL 1778 Uninterruptible Power Systems.
 - 8. American Standards of Testing and Materials (ASTM):B187-00 Standard Specification for Copper Bar, Bus Bar, Rod, and Shapes; and D635-98 Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
 - 9. ANSI/American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE): 52.1, Gravimetric and Dust Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
 - 10. ANSI/American Hardboard Association (AHA): 135.4, Basic Hardboard.
 - 11. The equipment manufacturer shall maintain ISO 9001 or ISO 9002 certification.
- B. Source Quality Control:
 - 1. Design and production tests: Perform and submit certified test results for the following tests on the uninterruptible power system or provide certified test reports on an identical unit. Furnish certified test reports showing test data and results as

well as manufacturer's comments on oscillograph traces obtained during in-rush test and short-circuit coordination tests.

- a. Rectifier/Charger: Perform tests to ensure that:
 - 1) Unit has capacity to feed specified load including overload capacity of static inverter.
 - 2) Output voltage regulation is within specified tolerance.
 - 3) Unit has specified efficiency at rated output.
 - 4) Unit is current limiting when activated by an external contact closure from an engine driven generator.
 - b. Static inverter: Perform tests to ensure that:
 - 1) Unit has capacity to feed rated kVA into load which has power factor of 0.8 lagging.
 - 2) Unit has capacity to deliver specified overload.
 - 3) Output voltage has sine wave with maximum of five-percent total harmonic distortion.
 - 4) Output voltage and frequency regulation are within specified limits.
 - 5) Efficiency at rated output at unity power factor of load is within specified limits.
 - c. Uninterruptible power supply: Perform following tests with UPS in normal operating mode and alternate power available on transfer switch:
 - 1) In-rush test: Test to verify that power transfer switch and inverter power circuits remain operative without reset or replacement of protective devices while the following test is performed:
 - a) With primary protection and full-load on secondary side as specified below connected to load side of power transfer switch, close transformer primary switch 10 times to provide maximum magnetizing in-rush. Record calibrated oscillograph traces of three-phase output voltages and line currents on load side of power transfer switch. Include oscillograph traces with the submittals.
 - 1) Inverter below 25 kVA: 9 kVA transformer with disconnect switch fused at 20 amperes on primary side.
 - 2) Inverter 25 kVA or larger: 15 kVA transformer with disconnect switch fused at 30 amperes on primary side.
 - 2) Input power factor: Test to determine input power factor at rated inverter output.
- C. Furnish products of a manufacturer regularly engaged in the manufacturing of industrial grade uninterruptible power systems.
- D. Qualifications of Instructor for Operation and Maintenance Training: Qualifications will be considered adequate when the following is demonstrated:
1. Instructor has in-depth knowledge of the design, packaging, operations, maintenance and trouble-shooting of the systems to be taught.
 2. Instructor has been trained in teaching methods or has previous satisfactory experience in teaching with emphasis on the subject matter to be covered in the course of instruction.

1.03 SUBMITTALS:

- A. General: Submit the following for approval:
- B. Shop Drawings: In accordance with requirements of table 1.
- C. Certification.
- D. Documentation:
 - 1. Submit field-test plan and documentation within sixty (60) days after award with accompanying documentation in the form of test-data recording sheets and list of proposed test equipment.
 - 2. Do not proceed with testing until plan and documentation are approved.
 - 3. Indicate in scope of test plan method of testing equipment in order to ensure safe and orderly transition from installation, through initial energizing, to specified field testing.
 - 4. Accompanying documentation to include data-recording sheets as used by manufacturer for in-plant testing of equipment and devices or as used by large industrial users of specified equipment.
 - 5. Submit certified copies of test data, dated and clearly identified within two weeks after completion of testing.
 - 6. Certified test data for specified enclosure intake filter performances.
 - 7. Instructor qualifications: Five copies of resume which outlines each instructor's qualifications and skills not later than 180 calendar days prior to commencement of training.
 - 8. All test reports shall be provided in electronic format.
- E. As-built drawing: All As-Built drawings provided shall comply with WMATA metadata requirements.
- F. Operations and maintenance training material: Submit five copies of training course descriptions and syllabus, training plans, instructor's guide, recommended class size, qualifications and resumes of all instructors, sixty (60) days prior to commencement of training.
- G. Operation and Maintenance (O&M) Manuals:
 - 1. Operation manuals should contain information pertaining to the operation of the UPS. The maintenance manual shall be a compilation of all the technical information related to the maintenance of the equipment, and/or system. Information pertaining to equipment identification, preventive maintenance instructions, parts list, recommended spare parts, wiring diagrams, shop drawings, special tools, and test equipment.
 - 2. Each illustrated part breakdown shall be provided with the following information: manufacturer's name, make or model number, serial number, size, voltage, phase, and other pertinent information.
 - 3. The Authority shall have the right to retain and reproduce unlimited copies of the O&M manuals as required for the Authority's use.

4. Include in O&M manuals general theory of operation of the UPS including description, purpose and function of:
 - 1) Battery.
 - 2) Rectifier/Charger.
 - 3) Inverter.
 - 4) Transfer switch.
 - 5) Maintenance bypass arrangement.
 - 6) Logic power supplies.
 - 7) All logic boards.
5. Describe and include in O&M manuals procedures for:
 - 1) Battery testing and optimizing:
 - a) Float voltages.
 - b) Equalizing voltages.
 - c) Equalizing time adjustments.
 - 2) Operational checks of:
 - a) Transfer to bypass source.
 - b) Retransfer from bypass to inverter.
 - 3) Alignment and adjustment of operating, detector and alarm circuits including rectifier, inverter and power transfer switch logic boards.
 - 4) Troubleshooting to include test procedures and system logic in identifying malfunctions.

H. Preventive Maintenance Instruction:

1. A Preventive Maintenance Instruction (PMI) shall be provided as a separate document. The PMI shall detail all the necessary maintenance requirements and frequency (interval) that is necessary to ensure continued safe and reliable operation of the UPS.
2. The PMI procedures shall be written in language that is easily understood.
3. The document shall be submitted in an electronic format that can be easily edited.
4. The PMI shall include step-by-step instructions to verify and document that the tested mechanism or circuit or subsystem functions are within operating parameters. It shall also include adjustment instructions for any mechanism or circuit found to be out-of-adjustment.
5. The PMI shall include data sheets and checklists for data collection regarding conditions of critical items.
6. The PMI shall include data sheets and checklists for data collection regarding conditions of critical items.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Ship each unit securely packaged and labeled for safe handling in shipment and to avoid damage or distortion.
- B. Temporary Bracing: Where necessary, brace each unit for hoisting, lowering and skidding into position. Temporary internal bracing of the equipment labeled as follows: TEMPORARY-REMOVE BEFORE OPERATION.
- C. Protection against concealed damage: Include within shipping container mechanical impact recorder of rating recommended by manufacturer for shipment by railroad and

submit impact chart with manufacturer's recommendations for disposition of damaged materials.

- D. Store equipment in secure and dry storage facility.

1.05 TRAINING:

A. OPERATION AND MAINTENANCE TRAINING:

1. Submit five (5) copies of training course descriptions and syllabus, training plan, instructor's guide, recommended class size, course provider's qualifications and instructors' resumes two (2) months prior to commencement of training for approval.
2. Perform operation and maintenance training in accordance with the Contract's requirements and the following additional requirements for development and performance of operation and maintenance training for uninterruptible power supply.
3. Use only instructors who have a minimum of five (5) years of hands on maintenance and troubleshooting experience on UPS, and in depth, specific knowledge of all of the major parts of the equipment.
4. Training Requirements:
 - a. The following three (3) different levels of training shall be provided under this contract:
 - 1) **Level 1: Operations and Maintenance staff**
 - a) Content: In a first theoretical part the participants will learn how the integral systems are assembled by means of circuit diagrams. In the following practical part, the participants will learn how to operate the UPS system in a safe manner.
 - b) Requirements: The training will be geared towards participants who have firm knowledge in electronics.
 - c) Duration / Location: Duration of each course session shall be one (1) day at WMATA's facility.
 - 2) **Level 2: Operations and Maintenance staff**
 - a) Content: This training course is built upon level 1 training. The participants will learn basic functions of different system units. Additionally, they will learn how to troubleshoot the UPS system for common alarms.
 - b) Requirements: Course level 1 must be successfully completed. The course will be geared towards participants who have a have firm knowledge in Electronics.
 - c) Duration / Location: Duration of each course session shall be two (2) days at WMATA's facility.
 - 3) **Level 3: Maintenance staff and Service Engineers**

- a) Content: The participants will have the opportunity to analyze and repair complex system malfunctions. This level enables participants to carry out the most common repairs and maintenance work on used training equipment.
- b) Requirements: Course level 1 and level 2 must be successfully completed. Participants must have solid knowledge in Electronics. Previous experience with UPS systems is preferred.
- c) Duration / Location: The duration of this course is two (2) days, depending on the requirements and previous experience of the participants. This training will be conducted at WMATA's facility.

5. Concept of Training:

- a. Design classroom and field instruction to cover, in detail, the functions of each item of equipment. Cover fault isolation and troubleshooting techniques to the extent necessary to permit a technician to diagnose and repair faulty modules. Design instruction to provide Authority maintenance personnel with practical experience in the performance of preventive and corrective maintenance. Provide troubleshooting and fault isolation of simulated faults for each item of equipment in the unit substation.
- b. Develop and provide all operations and maintenance training necessary for Authority-designated personnel to support the power equipment. Classroom instruction will include, not only the anatomy and functioning of all UPS's parts, but also the essentials of their routine care, including lubrication schedules, adjustments, limits, test frequency, inspection frequency, troubleshooting, removal and replacement. Instruction will cover theory of operation of the power systems, individual modules and special protective circuits. Instructors will use flow diagrams to show sequence of events and time required to complete each event.
- c. The course shall include performance of preventive maintenance operations on the equipment and hands-on troubleshooting of each subsystem.
- d. Instructors shall assume that the Authority's employees have no knowledge of the features or function of the new equipment. The Authority is permitted to videotape all class presentations.

6. Training materials:

- a. Training materials shall be submitted in both paper and electronic (pdf) format.
- b. Training shall be conducted using final manuals approved by the Authority and certified by the Contractor as being correct, as-built and reproducible. These materials will be the Authority's property once delivered.
- c. Develop the following training materials for each course:
 - 1) Instructor material for each course.
 - 2) Course outline: Course outline with learning objectives. Include a topic outline for each item of equipment. Include in maintenance training a section devoted to system-fault analysis and troubleshooting. State the learning objectives for each topic.

- 3) Lesson plans: A set of lesson plans for each item of equipment, corresponding to the topic outline, and containing the following information:
 - a) Lesson title.
 - b) Instruction time.
 - c) Objectives.
 - d) Training aids required.
 - e) Instruction sequence (outline).
 - f) Tests.
 - g) Summary.
 - 4) Training aids: For each topic, develop optimum use of visual aids, including transparencies size eight-inch by 10-inch, 35-mm slides, films, and mockups. Provide approved shop drawings in transparency.
 - 5) Instructional material: Use the applicable equipment operation and maintenance manuals as the primary source of instructional material. In addition, develop notebooks for each course containing such additional drawings, descriptive information and procedures necessary to ensure that the learning objectives are met in an orderly and timely manner. Arrange notebook material by each item of equipment and sequence according to the topic outline.
 - 6) Course topic outlines and schedules: Have the topic outline and schedules for each course contain the following:
 - a) Description of course including course objectives and training program level.
 - b) Course length and recommended numbers of students per course.
 - c) List of training materials required including documentation and equipment.
 - d) For each topic outline, include a topic objective and the time allotment to the topic.
 - e) List schedules for major topics and subtopics.
 - 7) Instructor guides and training aids for each course shall include:
 - a) Table of contents listing each topic and the time allotted.
 - b) List of applicable documents.
 - c) List of training materials.
 - d) Course learning objectives, course length and recommended number of students.
 - e) Provide each topic with a cover sheet listing topic, objective, time allotted and training aids required.
 - f) Include training aids with the instructor guides.
 - 8) Student workbook: Provide diagrams, drawings and procedures from engineering data and manuals.
7. Instructional Equipment: Conduct training utilizing installed equipment in normal operating conditions, permitting the trainees to perform hands-on work.
 8. Course of Instruction: Conduct this course for Authority-designated individuals; providing in-depth instruction on the fundamentals involved in the design of the complete system combined with practical aspects of operation and maintenance.

Include also the following:

- 1) Practical exercises that require the trainees to make use of the operation and maintenance manuals.
 - 2) Familiarization with the assembly, subassembly and components that make up a total system. Include instruction and practical exercises in troubleshooting at a level higher than that performed by equipment operators.
 - 3) Use and replacement of original assemblies, subassemblies and components with compatible assemblies, subassemblies and components manufactured by others.
 - 4) Handouts to each trainee that include information drawings, shop drawings, catalog cuts, manufacturer's literature, equipment maintenance check lists, and other literature describing the total system.
 - 5) Video and color slide presentations showing system installation, operation, troubleshooting, maintenance, module removal and replacement.
 - 6) Tools and test equipment necessary to conduct operation and equipment maintenance troubleshooting.
- b. Supplemental Training: In the event Contractor changes or performs modifications to equipment subsequent to the training that impact form, fit or function; provide supplementary training to the Authority's training instructor on a one-time basis.
9. Supplemental Training: In the event Contractor changes or performs modifications to equipment subsequent to the training that impacts form, fit or function, Contractor will provide supplementary training to the Authority's training instructor on a one-time basis.
- B. Equipment:
1. Training equipment: Supply and deliver to the Engineer after completion of the course, special tools required for maintenance training.
 2. Test equipment: Supply and deliver to the Engineer after completion of the course, test equipment required for maintenance training.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Furnished UPS of a manufacturer regularly engaged in the manufacturing of industrial grade uninterruptible power systems. The manufacturer shall demonstrate that its equipment can operate in dirty and harsh environments, such as, heavy rail transit underground tunnel facilities.

2.02 PRODUCTS AND MATERIALS:

- A. General: Comply with NEMA PE1.
1. Interchangeability: Components of same type, size, rating, functional characteristics and make are to be interchangeable.
 2. Enclosure:
 - a. Rectifier/charger, inverter, and power transfer switch provided with

- common ANSI/NEMA 250, Type 1-PFVF enclosure (pressurized forced ventilation with inlet air filters), with gasketed dust-tight doors.
- b. Intake filter: Two stage intake filter assembly that is easily removable from front of unit. The initial filter shall be composed of a metal material capable of removing airborne brake dust containing electrostatically charged particles and field washable. The secondary filter shall be a replaceable material providing an average ANSI/ASHRAE 52.1 efficiency of 30-percent and an average ANSI/ASHRAE 52.1 arrestance of 95-percent.
 - c. Design: Panel-type, with hinged front door suitable for mounting meters and accessories, ventilated for satisfactory operation of equipment under ambient temperature up to 105 degrees F.
 - d. Fabricated from minimum 14-gauge steel sheet and reinforced with steel framework to form rigid structure with smooth outer surface free of burrs, ridges or other blemishes.
 - e. Equipped with latch and handle; screw fastenings will not be accepted in lieu of latch.
 - f. Provision for grounding enclosure.
 - g. Finish: Metallic surfaces cleaned, degreased, primed with zinc primer and finished with light-gray enamel, ANSI Z55.1 Color 61, two mils minimum DFT.
3. Control and instrument wiring:
- a. Factory-installed.
 - b. Wire: Type SIS tinned-copper wire, 22AWG minimum for control logic and printed circuit card and 18AWG minimum for other control circuits. Class C or D stranded wire used for wiring across hinged joints.
 - c. Wire terminals: Tinned-copper ring or spade-type compression terminals with insulated sleeves installed in accordance with manufacturer's recommendations.
 - d. Wire identification: Each wire identified with the circuit number corresponding to that shown on wiring diagrams adjacent to terminal connections.
4. Fuses: Current-limiting fuse installed in each control circuit and where necessary for protection and coordination in power circuits.
5. Nameplates:
- a. Provide nameplate on each UPS in accordance with reference standards.
 - b. Three-ply, laminated phenolic plates; engraved through black face to white core and attached by means of steel rivets or screws.
 - 1) Lettering to be vertical Gothic using a round or square cutter. V-shaped groove not acceptable.
 - 2) Each UPS enclosure labeled with nameplate 1-1/2 inches high with letters one-inch high: UNINTERRUPTIBLE POWER SYSTEM.
 - c. Provide nameplate on each charger, battery, inverter and power transfer switch showing manufacturer's name, brand designation, reference standard, type, class, rating, wiring diagram and serial number, as applicable.
 - d. In addition to other information normally displayed on the equipment, provide nameplates showing switch positions, meaning of indicator lamps and other pertinent information.

6. System controls and indicators: Located on the front of the UPS cabinet; and as per manufacturer standard product with the following minimum requirements:
 - a. **Monitoring and control:** Provide a microprocessor based unit status display and controls section designed for convenient and reliable user operation. The monitoring functions such as metering status and alarms shall be displayed on a graphical LCD display. Additional feature of the monitoring and control system shall include graphical display of single line diagram of the UPS, menu-driven with pushbutton navigation, real time clock, alarm history with time and date, and battery back-up memory. All operations and parameters shall be firmware controlled, thus eliminating the need for manual adjustments or potentiometers.
 - b. Communications:
 - 1) The system shall be integrated with communication interface capable of communicating over RS485, TCP/IP Ethernet, with a PLC or SCADA using Modbus over TCP/IP Ethernet protocol, DNP-3 protocol, receive Modbus commands and send status information to external systems. RS232 is not recommended.
 - 2) **Web Interface:** The UPS communication interface shall including a web server functionality for remote monitoring of status, parameters, alarm log and measurement data using PC Windows Internet browser.
 - 3) Remote access to the UPS via Ethernet interface and/ or Fiber optic interface shall be provided in each unit for remote monitoring, configuration of parameters, and retrieval of data.
 - 4) Hardwired Alarms: The UPS shall be provided with the following form "C " contacts to be field wired to the station RTU for remote monitoring by Operation Control Center:
 - (a) UPS rectifier Alarm (Normal/Abnormal)
 - (b) UPS Transfer Switch position (Normal/Abnormal)
 - (c) UPS Inverter Alarm (Normal/Abnormal)
 - c. Metering display:
 - 1) Input AC voltage, line to line;
 - 2) Input AC current for each phase;
 - 3) Input frequency;
 - 4) DC bus voltage;
 - 5) Battery current and direction (charge/discharge);
 - 6) System output AC voltage, line to line and line to neutral for each phase;
 - 7) System output AC current for each phase;
 - 8) System output frequency;
 - 9) Bypass input voltage, line to line, line to neutral for each phase;
 - 10) Elapsed time-discharging battery;
7. Status displays, alarm messages and indication lights: Minimum requirement as specified for the rectifier/charger, inverter and power transfer switch units with the following additional requirements:
 - a. Indication lights: Long-life LED.
 - b. Clear identification of each indication light.
 - c. All alarm messages and indications resettable with push-button.
 - d. Controls: A graphical LCD mimic screen to depict a single line diagram of the UPS with switch positions and power flow.
 - e. Operation Instructions: Display to provide all necessary instructions and

- step-by-step procedures for each sequence of operation.
- 8. Accessibility of circuit boards and components:
 - a. Front accessibility to rectifier/charger, inverter, and power transfer switch, including all cable connections.
 - b. Where a circuit-alignment procedure is required and adjustments require measurement of circuit points on circuit boards: Accessible test points on cards with appropriate designations and supplementary removable extender boards provided for making points accessible.
 - c. Sub-assemblies, parts and circuit boards that may require replacement: Arranged and mounted so that replacement requires no soldering or special tools.
 - d. All cable and conduit connections: Through top of cabinet.
- 9. Operational noise level: Not exceeding 70dB measured six feet from the equipment on the A weighting network of a general-purpose sound-level meter at slow response. Test conditions and correction factors in accordance with ANSI/IEEE C57.12.90.
- 10. Supervisory contacts: As specified for the rectifier/charger, inverter and power transfer switch units, with the following additional requirements:
 - a. Dry-type sealed contacts rated to switch 500 milli-amperes at 250 volts dc or three amperes at 24 volts dc.
 - b. Contact resistance: 0.10-ohm maximum.
 - c. Contact bounce: Five milliseconds maximum.
 - d. Wired to terminal block for remote connection to supervisory system.
- B. Rectifier/Charger:
 - 1. Solid-state, three-phase: Continuous-duty rectifier including the following requirements:
 - a. Bridge rectifiers: Silicon-controlled or power transistor.
 - b. Twelve-pulse, each pulse fully controlled.
 - c. Electronic current-limiting control for output.
 - d. Output voltage: Maximum six-percent rms ripple with battery not connected.
 - 2. Electrical characteristics:
 - a. For converting 480-volt, three-phase, 60 Hertz alternating current to direct current with characteristics suitable for charging associated battery system and for providing input to the associated inverter. Rated input voltage 480 volts 3 phase.
 - b. 62.5 rated kVA.
 - c. Float and equalizing charge rate: As necessary for proper charging of associated battery, with the following additional requirements:
 - 1) Float voltage adjustable between 125 and 135 volts.
 - 2) Equalizing voltage adjustable between 135 and 144 volts.
 - d. Output rating: To provide dc input to inverter for giving rated inverter output while simultaneously providing average load of 1.8-kW dc for switchgear loads as specified, with sufficient rating to simultaneously recharge the battery to 90-percent or more of fully charged condition in a 12-hour period from a discharged battery voltage of 105 volts.
 - e. Output voltage regulation: Within plus-or-minus one percent from zero to 100-percent of charger rated capacity for ac supply-voltage variation of plus-or-minus 10-percent from rated input voltage and supply-frequency variation of plus-or-minus five-percent at 60 Hertz.

- f. Efficiency: 95-percent minimum at nominal input voltage with rectifier/charger supplying 100-percent of rated load.
- g. Power factor: Input power factor minimum 0.9 with rated input voltage, UPS supplying 100-percent load, and battery on minimum float voltage.
- 3. Accessory equipment:
 - a. Digital power quality meter.
 - b. Indicating lights or status displays:
 - 1) One to monitor ac supply voltage (low voltage or loss on any phase).
 - 2) Status displays:
 - a) Input circuit breaker closed.
 - b) Rectifier/charger in float or equalizing mode.
 - c) Rectifier/charger failed.
 - d) Ground-fault indication lights.
 - c. Relay equipped with one NO contact and one NC contact for indicating normal and failure status of rectifier/charger output at remote location.
 - d. One 480-volt, three-pole, molded-case circuit breaker to protect against available short-circuit current of 42 kA.
- 4. Automatic control:
 - a. Current-limiting device or circuit capable of limiting output current to rating of charger without disconnecting charger from battery or ac power supply. Provide a current limit, 0% to 25% (adjustable) of nominal full load current to limit the battery recharge current when activated by a remote.
 - b. Automatic recharging on equalizing cycle after return of input ac voltage following an outage. Input current rate of increase limited (ramped) to achieve full-load input capability in no more than 15 seconds after turn-on.
 - c. Adjustable equalizing timer with range from one-hour to 24 hours (minimum. Timer-adjustment function identified).
 - d. Built-in overload protection including short circuit at output terminals.
- 5. Manual control:
 - a. Manual momentary contact switch to initiate equalizing operation and timer.
 - b. Manual momentary contact switch to stop equalizing operation, restore float operation and reset timer.
 - c. Screwdriver slot or locking knob-operated devices for adjusting float voltage and equalizing voltage, with function identified.
- C. Static Inverter:
 - 1. Solid-state design using Insulated Gate Bipolar Transistor (IGBT) with Pulse Width Modulation/Stepwave.
 - 2. Electrical characteristics:
 - a. Input voltage: Nominal input-voltage range from low voltage of 105 volt to highest equalizing voltage of 144 volts as specified for battery.
 - b. Output voltage: 480Y/277-volt, three-phase, four-wire, 60 Hertz.
 - c. Output rating:
 - 1) kVA rating: 62.5.
 - 2) Capable of delivering rated three-phase KVA with any one phase 30-percent unbalanced from the other two phases within the dc input-voltage limits, and not exceeding three-percent voltage

- unbalance for any phase combination with no manual adjustment.
 - 3) Capable of delivering rated kVA into load which has power factor of 0.8 lagging.
 - d. Output-wave form: Sine wave, maximum of five-percent total harmonic distortion.
 - e. Output-voltage regulation: Zero to 100-percent rated load and dc input voltage within stated limits:
 - 1) Balanced load: Plus-or-minus one percent.
 - 2) Unbalanced load at 30-percent of rated load: Plus-or-minus 2.5 percent.
 - f. Output-voltage stability: With 100-percent step-load change, balanced load: Plus-or-minus 10-percent maximum deviation. Recovery to stated regulation band within six cycles.
 - g. Output-frequency control and synchronization:
 - 1) Inverter-output frequency phase locked to bypass source whenever source frequency is within plus-or-minus two-percent of standard 60 Hertz.
 - 2) Inverter-frequency control to shift to crystal- controlled oscillator in inverter whenever utility reference frequency goes outside limits. Whenever utility source returns within the frequency limits, frequency control to return to bypass source.
 - 3) Crystal-controlled oscillator to maintain a stable, continuous, standard 60-Hertz frequency within plus-or-minus one-half percent.
 - 4) Phase-lock control to maintain output-voltage wave of each phase to within six electrical degrees of the utility voltage wave (bypass source).
 - h. Overload rating: 125-percent of rated load for 15 minutes (without bypass source); 200-percent for 30 seconds (without bypass source).
 - i. Starting characteristics: Capacity to start at any load within overload rating with and without external ac power source.
 - j. Fault and surge override: Capacity to:
 - 1) Sustain fault at load terminals of main emergency panelboard until fault is cleared or load is transferred.
 - 2) Override magnetizing in-rush current of transformer as follows:
 - a) Inverter below 15 kVA: Nine-kVA transformer.
 - b) Inverter 25 kVA and larger: 15-kVA transformer.
 - k. Inverter automatic shutdown: To occur when battery voltage reaches lower limit of 105 volts. Battery to continue to supply the specified switchgear load.
 - l. Inverter to restart automatically when dc voltage reaches nominal value of 125 volts.
 - m. Efficiency: Not less than the following with load power factor of 0.8 lagging.
 - 1) 15 kVA or less: 80-percent.
 - 2) 20 kVA through 62.5 kVA: 90-percent.
3. Accessory equipment:
 - a. Digital power panel meter.
 - b. Indicating lights or status displays:
 - 1) Inverter operating in normal mode.

- 2) Inverter operating in standby mode or power transfer switch in bypass mode.
 - 3) Inverter operating and phase locked.
 - 4) DC voltage below minimum float voltage or above maximum equalizing voltage.
 - 5) Over-temperature.
 - 6) Low cooling air flow.
 - 7) Overload.
 - c. Relays and controls:
 - 1) Adjustable three-phase undervoltage relay or static circuitry to sense each phase of inverter output for initiating transfer to bypass power source. Initiation voltage adjustable over range of 80-percent to 90-percent of rated voltage.
 - 2) Voltage-sensing circuitry to prevent retransfer of load to the inverter unless voltage is within specified tolerance and frequency is phase locked within tolerance.
 - 3) Signals from the frequency and synchronization control to be used to inhibit retransfer from bypass to inverter if out-of-tolerance.
 - 4) Inverter control for restarting of a shutdown inverter.
 - 5) Manual ON/OFF control switch/keypad. ON position of switch/keypad to restart inverter for full-automatic operation.
 - 6) Devices and circuitry to protect inverter from dc over/under voltage, overload, short-circuit, and over-temperature.
 - 7) Device and circuitry equipped with two supervisory contacts, one NC and one NO, for remote monitoring inverter-output status.
- D. Static Transfer Switch: An integral part of the UPS, silicon-controlled rectifier-type with the following requirements:
1. Automatic transfer of inverter load to bypass source: Transfer to be made under the following conditions provided transfer/retransfer selector switch is in automatic position:
 - a. Inverter-output failure occurs.
 - b. Overload is equal to or less than 25-percent for more than 15 minutes.
 - c. Overload greater than 25-percent occurs.
 - d. Inverter is shutdown with manual switch.
 2. Automatic retransfer of load to inverter: Retransfer to be made under following conditions provided transfer/retransfer selector switch is in automatic position:
 - a. The overload condition is removed.
 - b. Inverter-output voltage is within specified tolerance for magnitude and frequency and within six electrical degrees of the bypass-source voltage.
 3. Manual transfer and retransfer:
 - a. Transfer of inverter load to the bypass source initiated by a switch closure. Inverter to remain operating and ready to accept the load.
 - b. Retransfer initiated by automatic control when transfer/retransfer selector switch is in automatic position.
 4. Switch or control panel keypad identified as a transfer/retransfer selector switch/control panel keypad: Two-position selector switch or control panel keypad with positions labeled as follows:
 - a. AUTOMATIC (TRANSFER AND RETRANSFER).
 - b. MANUAL TRANSFER (INHIBIT RETRANSFER).

5. Electrical characteristics:
 - a. Rated voltage: 480/277-volt, three-phase, 60 Hertz with neutral bus for four-wire bypass-source service and UPS-output neutral connection.
 - b. Rated continuous current: 125% rated load continuously and 200% rated load for 30 seconds.
 - c. Withstand capability: Withstand short-circuit current available at bypass source. Vendor may provide current-limiting protection to provide required withstand. Current-limiting fuses to provide coordination with the bypass source and the branch-circuit protection in the main emergency panelboard.
 - d. Capacity to close into short-circuit or let-through of fuses without functional degrading other than fuse clearing.
6. Indicating lights or status displays:
 - a. Bypass-source undervoltage, overvoltage, loss of a phase, or out-of-frequency tolerance.
 - b. Power transfer switch on bypass.
7. Maintenance bypass capability:
 - a. A manually operated maintenance bypass switching arrangement to transfer the UPS output load to the bypass ac source without interruption of UPS output while electronically isolating or permitting the isolation of the static transfer switch and the inverter from the bypass source.
8. Circuit and device with two supervisory contacts, one NO and one NC for monitoring status of power transfer switch feeding load from inverter output or from bypass source.

Table 1 List of Shop Drawings	
Item	Requirements
1	Outline dimensions, including weights and foundation requirements for equipment to be furnished
2	Front views, floor plans, and mounting details for equipment to be furnished
3	One-line block diagrams
4	List of standard symbols and nomenclature
5	Elementary diagrams with description of each circuit
6	Interconnection wiring diagram
7	Wiring diagrams, showing internal wiring of equipment furnished

END OF SECTION

TYPICAL UPS SINGLE LINE

