SECTION 26 34 37

UNINTERRUPTIBLE POWER SUPPLY (UPS)

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. System requirements.

B. Rectifier/charger.

C. Inverter.

D. Static Transfer switch.

E. Maintenance transfer switch.

F. Batteries.

G. Controls.

H. Metering.

I. Indicators.

1.02 MEASUREMENT AND PAYMENT

A. General: UPS Power Supply, as specified herein, will not be measured separately for payment but will be paid for as part of the Contract lump-sum price for the related electrical or electronic systems work as indicated in the Bid Schedule of the Bid Form.

1.03 SUBMITTALS

A. General: Refer to Section 01 33 00, Submittal Procedures, and Section 01 33 23, Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.

B. Submit product information and catalog cuts of UPS equipment components and devices.

C. The contractor shall provide dimensioned general plan and elevation of equipment.

D. After the receipt of notice to Proceed, the contractor shall submit within three weeks all required drawings and specifications for review.

E. Include as shop drawings:

1. equipment dimensions,

2. performance curves for range of operation,

3. selection criteria,

4. installation requirements and layouts,

5. details of construction,

6. technical description,

7. wiring diagrams,

8. drawing clearly indicating field wiring, piping and the other work to be completed by the Contractor, and

9. shop drawing to be included for all accessories, replaceable components and components purchased from third party and becoming part of the installations.

F. Complete specifications on over all UPS systems including sub system specifications from the original manufactures shall be submitted to BART Engineering for pre approval.

G. Review of shop drawings by the Engineer for general conformance only and shall not relieve the Contractor of responsibility for supplying equipment which complies with the specifications and functional requirements and good engineering practice.

H. Supplier Qualifications

1. The manufactures of the UPS must have a minimum of 5 years of manufacturing experience.

2. UPS shall be standard products from manufactures.

1.04 REFERENCES

A. International Electrotechnical Commission (IEC):

1. IEC 60068-1 Environmental Testing Part 1: General and Guidance

B. Institute of Electrical and Electronic Engineers (IEEE):

1. IEEE C62.41 IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

C. Federal Communications Commission (FCC):

1. FCC Rules and Regulation 47, Part 15 Radio Frequency Devices

D. National Electrical Manufacturers Association (NEMA):

1. NEMA PE-1 Interruptible Power Systems (UPS)- Specification and Performance Verification

E. National Fire Protection Association (NFPA):

1. NFPA 70 National Electric Code

F. Underwriters Laboratory, Inc. (UL):

1. UL 1778 Standard for Uninterruptible Power Systems

G. Telecommunications Industry Association (TIA):

1. TIA-232 Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

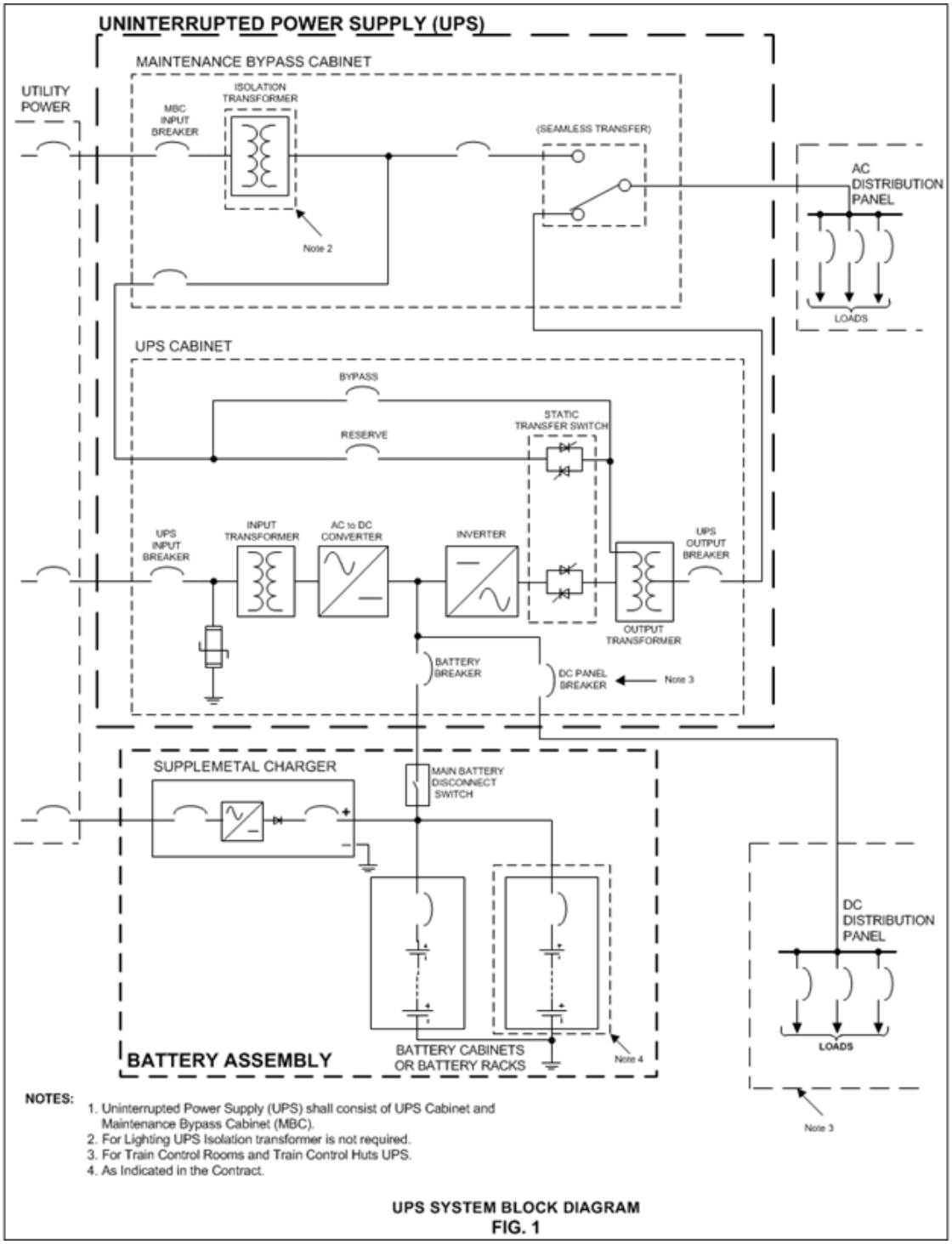
2. TIA-485 Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

1.05 WARRANTY

A. UPS: The warranty of the UPS shall be no less than 12 months after acceptance and must include all costs including repair, parts, labor, travel and living expenses for the manufacturer's service personnel.

B. Battery: See the battery specification, Section 26 33 01, for warranty.

C. If required during the warranty period, the UPS Supplier will be providing all necessary labor, materials, and repair related expenses.



UPS SYSTEM BLOCK DIAGRAM
FIG. 1

PART 2 – PRODUCTS

2.01 SYSTEM REQUIREMENTS

The following system requirements are applicable to all BART UPS.

A. **General**:

1. The UPS System consists of UPS Cabinet, Maintenance Bypass Cabinet (MBC) and Battery Assembly as specified in the contract documents.

2. All UPS Equipment to be provided by one manufacturer.

3. Testing of All UPS Equipment is to be conducted at the site with the UPS systems fully assembled.

4. UPS: The UPS shall consist of the UPS Cabinet, isolation transformers, maintenance bypass Cabinet (MBC), static transfer switch and the other features described in the specifications and shown on block diagram figure 1.

5. The following are the typical loads

   a. BART Control, Communication Systems and Lighting

   b. Emergency lighting inverter for stations

   c. Operation Control Center (OCC)

   d. Computer, servers etc.

B. **Modes of Operation:**

1. UPS

   a. The ups shall be an on-line type and make-before-break operation during load transfer.

   b. **Normal operation:** Under normal operation the power will be transferred through the UPS converter systems. The output ac voltage will be fully regulated; the output will be isolated from the input through an isolation transformer.

   c. **Loss of normal input power:** When the input AC power fails there will be no interruption of power as the UPS inverter will continue to power the load from stored battery system's dc bus. The battery shall continue to supply power to the inverter at rated full load for the specified time.

   d. **Return of Normal Power:** The UPS system will automatically return to normal operation as described in (a) with no interruption to essential load The transfer to normal utility power will be initiated only after ascertaining stable return of input ac voltage after several cycles.

   e. **UPS internal fault:** When there is failure in the UPS inverter or the battery system unable to supply power, a control signal will inhibit the inverter

operation and the power will continue to be transferred from input ac to the output through the static by-pass switch as shown in the block diagram (figure 1).

f. **UPS replacement/maintenance:** In the event the UPS needed to be replaced the input external by-pass switch will be closed and output disconnect switch will be open manually, allowing total by-pass of the UPS for safe removal (see figure 1).

g. **Operation without batteries:** If the battery is taken out of service for any reason, the UPS shall continue to function from the input ac source through static by-pass or external mechanical by-pass switch.

C. **Power Rating:**

1. The UPS shall size in accordance with the District-approved power calculations to support the connected load with a minimum of 20 percent margin of UPS rating. The input line voltage, load voltage and input bypass line voltage shall be as indicated in the Contract drawings. Product information for the UPS shall be submitted to the District for approval.

2. The UPS battery shall have capacity to support the load as calculated above at each location for duration as specified in the detailed specification for that application.

D. **Electrical Requirements:**

1. Acoustical Noise: Noise generated by the UPS under any condition of normal operation shall not exceed the allowable sound pressure level of 65 dBA measured at 1 meter from the nearest surface of the cabinet.

2. EMI Suppression: The UPS shall meet FCC rules and regulation 47.

3. Electrostatic Discharge (ESD): The UPS shall withstand up to 25KV without damage and with no disturbance or adverse effect to the critical load.

4. Efficiency: The UPS efficiency shall be a minimum of 80 percent at 50 percent load.

5. Input Surge Withstanding Capability: The UPS/LI shall be in compliance with IEEE C62.41, North American and International standards, which include ANSI C62.41.

E. **Input Ratings:**

1. Input voltage — As specified in the contract documents.

2. Input Voltage Range — +10 percent, -20 percent

3. Input Frequency Range — 53 to 67 Hz

4. Phase Unbalance — The UPS shall not be impacted by input line phase unbalance up to plus or minus 10 percent. The output phase unbalance shall not be contributed by the UPS inverters.

5. Power Factor — 0.8 lagging to 0.8 leading at full load

6. Current Limit — 125 percent full load maximum

7. Protection — The unit shall be self protected against unwanted over-voltage including line over-voltage and transients such as switching surge and lightning, over-current including short circuits per NFPA 70, NEC requirements as shown in the block diagram (figure 1)

8. Inrush current — Soft start shall be used to limit no more than 1.5 x Full load for a duration not exceeding 100 milliseconds.

9. Input Transformer — Δ: Y

10. Isolation — Input shall be isolated from the ac system by an isolation transformer where called for. The isolation voltage of the transformer shall be per applicable standards.

F. **Output Rating:**

1. Output Voltage Rating — As specified in the contract documents.

2. Output Power Rating — As specified in the contract documents.

3. Output Voltage Regulation — Within plus or minus 2 percent of output voltage

4. Output Frequency — Nominal 60 Hz, Plus or minus 0.5 Hz

5. Load Response — 1 millisecond

   a. Free running stability — Plus or minus 0.15 percent in 24 hours

   b. Stability — Plus or minus 1 percent in 6 months

6. Voltage Transients:

   a. Voltage transient shall not exceed more than plus or minus 5 percent for any change in load.

   b. Return of AC Power — Plus or minus 2 percent

   c. Manual transfer of load — Plus or minus 5 percent

      To UPS or bypass line

   d. Automatic transfer of load must have transient suppression network as well as suppressors.

7. Voltage transient recovery time to within 2 percent within 1 millisecond.

8.	Load power factor	0.8 lagging to 0.8 leading
9.	Total Harmonic Distortion (THD)	Less-Than 3 percent RMS maximum; Less-Than 2 percent any single harmonic
10.	Overloads	125 percent for 10 minutes; 115 percent for 1 hour
11.	Static transfer	1000 percent full load for 1 switch loading cycle; 200 percent full load for 5 minutes
12.	Hours of operation	8 Hours at full load for stations, 90 minutes for the emergency lightings, and other BART facilities as specified in the contract documents.
13.	Output Transformer	Secondary Y configuration
14.	Maximum cabinet size	As specified in the contract documents.
15.	Phase unbalance	100 percent (e.g. Phase A-10 percent, phase B-80 percent, phase C-10 percent)

G. **Controls Design and Operating Characteristics:**

1. Fully automatic operation of each UPS module shall be provided through the micro controllers.

2. All operating and protection parameters shall be firmware controlled, thus minimizing the need for manual adjustments. All adjustments and calibrations shall be performed once at production and at any time the operational parameter are modified. Printed circuit board replacement shall be possible with minimum calibration requirements.

3. Start up and transfer shall be automatic functions.

4. Multiple micro-controllers shall be used per module, so no single controller in a mission critical application.

5. All configurations, setup and calibration information shall be stored in a non volatile memory that does not require a control battery for data storage.

6. Emergency transfer to Bypass due to UPS module failure shall be independent of control logic controlling the rectifier/charger, inverter and monitor panel. Emergency transfer circuitry shall contain all the necessary circuitry to perform an emergency transfer without any other functioning logic.

7. Monitoring and communication logic shall be independent of rectifier/charger and inverter control logic. Circuitry and firmware required for monitoring and communications shall be functionally isolated from the Bypass, Rectifier/charger and Inverter controls. Monitoring firmware shall be field upgradeable.

8. The UPS module shall be programmable to optionally provide automatic restart capability following loss of utility and complete battery discharge. When utility power returns, the UPS module shall automatically energized the output terminals and subsequently transfer to Normal mode.

H. **Environmental Requirements:**

The UPS shall withstand any combination of the following external environment conditions without operational degradation.

1. Operating temperature: 32 degrees to 120 degrees Fahrenheit (0 degrees to 50 degrees Celcius)

2. Relative Humidity: 0 percent to 95 percent non condensing (Operating and storage)

I. **Reliability Maintainabilty:**

1. The calculated MTBF for the UPS shall be no less than 150,000 hours.

2. All power cables to power transformer and chokes shall be secured with permanent cold weld crimps, which required no maintenance or periodic retorquing.

3. Maintainability: Calculate and demonstrate mean-time-to-repair (MTTR) shall not exceeds 30 minutes, including the time to diagnose the problem and replace the sub assembly.

J. **Manuals:**

1. Provide copies of maintenance documentation.

2. Manuals to include

   a. Clear and permanent identification on the outside of the binder

   b. Detailed index

   c. All documentation to be 8 1/2” x 11” format

   d. List of supplier and authorized service representatives for the equipment and accessories supplied. Provide names, address and phone numbers

   e. Details of warranty

   f. List of recommended spare parts

   g. Step by step start up and shut down procedures

   h. Troubleshooting summary

   i. Itemized maintenance schedule and single page summary including recommended daily, weekly, monthly and yearly maintenance

j. Parts summary including make, model and part number to facilitate ordering of the replacement parts

k. Dimensioned general arrangement drawings

l. Include parts diagram and assembly drawing to permit tear down maintenance and/or repair

3. Include similar documentation for all purchased components not manufactured by manufacturer.

4. Manuals for all software shall be provided to the owners as applicable. Include copies of all installation specific or proprietary software necessary to maintain, reload or modify the system. Include latest hard copy and soft copy of software.

2.02 EQUIPMENT REQUIREMENTS

A. General

The UPS shall be designed for the operation in a non air conditioned room environment with temperature extremes of 32 degrees Fahrenheit and 120 degrees Fahrenheit (0 to 50 degrees Celsius) and humidity 0 percent to 95 percent non condensing. The UPS circuit shall be of modular for ease of replacement. The system shall have the capability of remote management, monitoring and control.

1. Modules shall be standardized such that Least Replaceable Unit (LRU) modules shall fit in the same slot without any need of modifications.

2. Access for maintenance shall be easy for removal of critical components. All critical components shall be configuring for self diagnoses. System status monitor shall have diagnostics and indicators identifying existing on the printed circuit modules. LED indicators shall light up and alert technician to system fault. Serviceable parts should be designed to physical separation from high voltage areas assuring safety of maintenance personals.

3. At minimum the UPS shall include all the sub system as outlined in the Block diagram (figure 1). In addition this will include all the control protection and monitoring circuits as necessary. Additional requirements will be defined by BART Engineering specification for a particular application. Any deviation from these specifications shall require BART Engineering's approval.

4. High stress, high voltages electronics switching components shall be plug and play for the ease in service and maintenance.

B. **Rectifier/Charger:**

1. The rectifier/charger shall convert incoming AC power to regulate the DC output for supplying the inverter and for charging the battery bank. The rectifier shall be twelve-pulse system design. The charger design shall be constant current type switching converter. The modular design of the UPS module shall permit easy removal of rectifier/charger without removal of any other assembly.

2. The rectifier shall charger shall automatically boost the charge to the battery after battery is drained. The boost charge shall allows a quick recharge and keep batteries in good condition without providing a constant float charge. It shall provide a controlled charging and load exercising of batteries to avoid battery deterioration. Controlled charging of the batteries shall prevent boiling and dehydration of electrolyte. Load exercising of the batteries shall keep batteries continuously cycled, alleviating cell deterioration. To prevent overcharging the boost charge shall stop when ambient temperature could cause damage to the batteries.

3. The charger shall be able to recharge the fully discharge battery capacity in 6 hours.

4. The charger unit shall be programmable and expandable up to as specified in the contract documents for additional battery modules if so desired at a future date.

5. The rectifier/charger shall be furnished with output filtering to limit the ripple currents into the battery.

C. **Inverter:**

1. The inverter shall be high frequency switching converter employing devices such as insulated-gate bipolar transistor (IGBT) technology. The inverter shall have the following features:

   a. The inverter shall be capable of providing the specified quality output power while operating from any DC voltage source (Rectifier or Battery) within the specified range.

   b. The modular design of the UPS shall permit easy removal of each phase of the inverter and DC electrolytic capacitors without removal of any other assembly.

2. The inverter shall have all the necessary input/output filtering and circuit necessary for regulation, protection and monitoring.

3. The dc input of the inverter shall have banks of filter capacitors. The loss of one bank shall not disrupt output voltage or a continued full load operation.

4. Protection:

   a. The inverter output shall be protected against over current (OC) and shall have current limiting circuit.

   b. The inverter input shall have surge protection.

   c. The inverter shall have an active soft start circuit to ramp up to output full voltage within 1 second.

d. The circuitry shall automatically synchronize and phase lock the inverter output to the alternate power source as long as the source is within 60 +0.5 Hz. If the alternate source is not within these limits, then the inverter shall lock to an internal oscillator.

e. The inverter shall automatically turn off at the dc voltage low level of 1.75 volts per cell.

f. Test points and LED's shall be provided to facilitate adjustments, diagnostics and identify circuit integrity.

g. It shall be possible to test logic circuitry without operating the power circuits.

D. **Internal Bypass (Static Transfer Switch):**

The bypass shall serve as an alternate source of power for essential load when a failure prevents operation in normal mode. A static transfer switch consisting of SCR shall be provided for automatic/manual transfer of loads from the inverter to the alternate power source. The static bypass switch only be necessary for controlling make before break transfer. The operation of the transfer switch shall be as follows:

1. Uninterrupted transfer to Static bypass shall be automatically initiated for the following conditions, at the same time turning off the inverter. The transfer shall be inhibited, if the alternate power source is not within specifications.

   a. Inverter under-voltage 90 percent of normal

   b. Inverter over-voltage 110 percent of normal

   c. Inverter overload 125 percent of rated load

   d. Inverter cabinet over temperature conditions

   e. Total battery discharge

   f. UPS module failure

   g. Manual initiation

2. Retransfer to Inverter: The static transfer switch shall be capable of automatically retransferring the load back to the inverter after the inverter has returned to normal operating conditions. Uninterrupted automatic retransfer takes place whenever the inverter is capable of assuming the critical load.

3. Uninterrupted automatic retransfer shall be inhibited for the following conditions

   a. UPS module failure

   b. In the event of multiple transfer-retransfer operation of the control circuitry shall limit to three operations in any 10 minute period. The forth transfer shall lock the critical load to the bypass source.

4. All transfer and re-transfers shall be inhibited for the following conditions

   a. Over and Under voltage by plus or minus 10 percent of nominal

b. Frequency out of limits by plus or minus 0.5 Hz

c. Bypass out of synchronization

d. Bypass phase rotational/installation error

5. The bypass shall be manually energized with a breaker internally mounted. No additional control logic required.

6. The control circuitry required to perform an emergency transfer to bypass shall operate independently from the inverter control circuitry.

7. The rectifier/charger input circuit breaker shall have no effect on Bypass operation.

8. Over current protection: Fuses shall be placed in the inverter input of the static transfer switch of both sources.

9. Surge protection: The static transfer switch shall have surge protection on the alternate source side.

E. **Maintenance Bypass Cabinet (MBC):**

A manually operated bypass switching arrangement shall be provided to permit transferring the essential loads to the alternate power source, without interruption of power and at the same time to electrically isolate the UPS/LI.

The manual bypass switch shall be electrically interlocked to prevent, back feeding the UPS output in the event of incorrect operation, e.g. transferring the load to bypass switch when the load supplied by the inverter.

UPS/LI shall initiate an audible alarm upon the transfer to manual bypass. The audio alarm shall be capable of being muted by the user. The alarm shall continue to sound while in bypass mode. This shall provide reminder to the user that load continues to be powered from utility or generator supply alone.

F. **Batteries:**

Batteries, battery racks/enclosures, and accessories shall be in accordance with the requirements specified in Section 26 33 01, DC Battery System.

1. **Battery testing:** The UPS shall perform and automatic battery test once a day and also allow for user remote and local selected battery tests. The test shall not compromise the output of UPS system and alert user through local and remote monitoring system any battery error.

2. **Battery contactor:** The UPS shall contain a two pole contactor for disconnecting the battery from the rectifier output and Inverter input. A contactor enable switch shall be located on the UPS module control panel. With the UPS module in bypass mode, the contactor shall permit the rectifier, inverter, DC capacitors and associated boards to be safely serviced without opening an External Battery Breaker.

3. **Battery Management System:** The UPS shall contain a battery management system which has the following features:

   a. The battery management shall provide battery time available, or percent remaining, while operating in Normal mode and battery mode. Battery time available shall be displayed in real time, even under changing load conditions. The battery time available information shall be within plus or minus 3 percent.

   b. The battery management system shall automatically analyze the UPS battery during a user defined periodic test. During the test, rectifier/charger shall not de-energize, but shall share load with the battery. For remaining battery time information, the battery shall test under the same load for each user defined periodic test. If the battery is weak or defective, the battery management system shall detect and annunciate the battery failure condition without transferring the critical load to the bypass.

   c. The periodic test performed by the battery management system shall not remove more than 10 percent of the available run time from the battery. The periodic test, if performed monthly basis, shall not reduce overall battery life.

   d. If the Utility outage occur while a test in progress, the test shall be discontinued and subsequently conducted at the next programmed interval. The occurrence of the test shall be user programmable for day, date and time.

   e. The battery management system shall record and display the pass/fail status, battery voltage and indicator value of previous 30 periodic tests.

   f. The battery management system shall annunciate a user programmable battery time remaining warning when the UPS on the battery power.

   g. The battery management system shall provide an imminent shut down alarm to signal a low battery condition.

   h. The battery management system shall work with either wet cell batteries or valve regulated batteries.

   i. The battery management system shall only place a charge on the batteries when the system detects a low battery condition or once a month (programmable). Charging and cycling in conjunction with the rectifier to cycle the batteries and preserve the life of the batteries.

   j. Charging current and time fully programmable.

G. **Wiring Terminals:**

1. The UPS/LI shall contain mechanical ratcheting compression terminals (adequately sized to accommodate 75 degrees Celsius wiring) for securing user wiring to the following locations

   a. Rectifier/charger connections

   b. Bypass connections

c. DC link connections

d. AC output connections

e. Transformer connections

H. **Controls:**

The UPS system shall be furnished with the following controls on or inside the UPS module cabinet.

1. Rectifier/Charger

   a. Input non-automatic disconnect

   b. DC float voltage adjustment

   c. DC boost (equalize) voltage adjustment

   d. Boost (equalize) voltage timer adjustment

   e. Boost (equalize) voltage initiation

   f. Boost (equalize) voltage timer reset

2. Inverter

   a. Inverter start

   b. Inverter stop

   c. DC under-voltage shut off adjustment

   d. Output AC voltage adjustment

3. Static transfer switch

   a. Transfer switch test

   b. Transfer switch setting adjustment

   c. Maintenance transfer switch

I. **Metering:**

The following parameters shall be individually metered with a digital read out and with an accuracy of 2 percent or better:

1. DC voltage, Rectifier/charger

2. Direct current: Rectifier/charger

3. AC voltage

   a. Input

   b. Output

4. Alternating current
5. Inverter
6. Alternate power source
7. Load
8. Frequency
9. Inverter
10. Alternate power source
11. Load

J. **Indicators:**

1. **Monitoring components:** The following components shall provide monitor and control capability
   a. Micro-controller driven circuitry
   b. Monitor panel with status indicators
   c. Alarm and metering display
   d. Various communication ports
2. **Monitor Panel Indicator:** The UPS module shall be equipped with a monitor panel providing the following monitor functions and indicators (each alarm and notice conditions shall be accompanied with an audible alarm)
   a. **NORMAL:** This indicator shall be lit when the UPS module is operating in Normal mode.
   b. **BATTERY:** This indicator shall be lit when the UPS module is operating in Battery mode. The Normal Indicator remains lit.
   c. **BYPASS:** This indicator shall be lit when the UPS module is operating in Bypass mode. The critical load is supporting by the Bypass source. The Normal indicator shall not be lit when UPS is in Bypass mode.
   d. **NOTICE:** This indicator shall be lit when the UPS module need attention. Some notices may be accompanied by an audible alarm. Notice shall include:
      1) Bypass not available
      2) Battery under voltage
   e. **STANDBY**: This indicator shall be lit when electricity is present in the rectifier and Inverter shall the Normal Indicator is not lit. During the start up this indicator remains lit until the UPS transfer to Normal mode, at which time the Normal indicator shall lit. During the shutdown the standby indictor shall

remain lit until all the energy in the UPS module is dissipated and shut down is complete.

f. **ALARMS:** This indicator shall be lit when the UPS module need immediate attention. Alarms in the form of flashing displays, shall be provided for the abnormal conditions specified below. Auxiliary contacts shall be provided for each abnormal condition as well as a summary alarm contact for connection to the Supervisory Control and Data Acquisition System. Circuitry shall be provided for one TIA-232 and one TIA-485 communication port. Provide one Ethernet (TCP/IP) I/O Base T, RJ45 connection for remote monitoring. The system shall be IP enabled. Alarm contacts shall latch until reset.

1) Low battery voltage and check battery
2) Over-temperature in the battery enclosure area
3) DC over-voltage
4) DC ground
5) Alternate power source
6) Static transfer switch position (in alternate power source)
7) Fan failure
8) Maintenance transfer switch position-ON
9) Battery carrying the load

g. **ALARM SILENCE BUTTON:** Display panel shall include alarm reset button. If the alarm reset button is pressed for 1 second, the current audible alarms shall be disabled. If a new alarm occurs, or a cancelled alarm condition disappear and re-appears and then audible alarm is re-enable.

h. **AUTOMATIC MESSAGING SYSTEM:** A means shall be provided to generate automatic dial signal for telephone and other messaging in the event of input AC power failure to UPS and a failure of the UPS itself.

K. **Enclosure:**

1. Rectifier/charger, inverter, all filtering, surge protection shall be installed in a NEMA 12 cabinets.

2. The output transformer, output filters ac signal conditioners shall be installed in a separate free standing NEMA 12 cabinets.

3. The enclosures shall be design for industrial applications in accordance with the environments requirements. The enclosures shall line up and match up in style and color.

4. Ventilation: The UPS shall be design for forced air cooling. Air inlets shall be in the lower front. Air outlet shall be in the as specified in the contract documents such as rear or the top. Twelve inches of clearance over the UPS air outlets shall be required for proper circulation. Air filters for the UPS shall be commonly available sizes and shall be easily removable from the base.

5. No back or side clearance shall be required for any enclosure. The back and side enclosure covers shall be capable being located directly adjacent to a wall.

6. Cooling Fans: The modular design to the UPS module shall permitted removal of each fan without the removal of any other assembly. Fan replacement shall be accomplished by removing no more than one fastener per fan and shall not require the removal of another sub assembly.

7. Cable entry: As specified in the contract documents such as top, bottom or side. A dedicated wire way shall be provided within the UPS for routing user input and output wiring. All wiring compartment to meet NFPA 70, NEC size requirements for cable turning radius.

8. Front Access: All serviceable shall be modular and capable of being replaced from the front of UPS. Removal and replacement of any subassembly shall not require removal of another subassembly. Side or rear access to UPS module shall not be required for UPS installation, service, repair or maintenance.

PART 3 – EXECUTION

3.01 FIELD QUALITY CONTROL AND COMMISSIONING

A. The following test shall be performed by the Field service personnel during the UPS start up:

1. **Visual inspection:**

   a. Visually inspect all equipment for signs of damage or foreign materials.

   b. Observe the type of ventilation, cleanliness of room, the use of proper signs, and any other safety related factors.

2. **Mechanical inspection:**

   a. Check all the power connections for tightness.

   b. Check all the control wiring terminations and plugs for the tightness or proper seating.

3. **Electrical pre check:**

   a. Check the DC bus for the possible short circuit.

   b. Check the input and the Bypass for the proper voltage and phase rotation. Check all test functions.

   c. Check all test functions.

4. **Initial Start up:**

   a. Verify that all the alarms are in a go condition.

b. Energized the UPS module and verify the proper DC, walkup and AC phase on.

c. Check the DC link voltage, AC output voltages, and output waveform.

d. Check the final DC link voltage and Inverter AC voltage output. Adjust if required.

e. Check for proper synchronization.

f. Check the voltage difference between the inverter output and bypass source.

5. **Operational instructions:** Before leaving the site, the field service engineer shall familiarize responsible personnel with the operation of the UPS. The UPS equipment shall be available for demonstration of the modes of operation.

B. The UPS power equipment manufacturer/supplier representative shall be an integral part of the project commission team. The UPS power equipment representative will be required to attend the regular schedule commissioning meetings to assist in start up scheduling and resolve system installation conflicts prior to actual start up.

3.02 TRAINING:

A. Following commissioning, provide training in maintenance and operation of the equipment to operators. Although the operators may be present during commissioning process, this is not to be considered part of training process.

B. Following commissioning, provide formal classroom and field training to operation staff using the maintenance manual provided.

C. Review contents of manual and discuss regular tear down maintenance and repair. Review maintenance diagnostic procedures and preventive maintenance practices.

D. Allow for two separate training sessions, a month apart

1. The first session will be four hours

2. The second will consist of a review and questions

3.03 SPARE PARTS LIST:

UPS supplier shall provide a recommended spare parts list.

END OF SECTION 26 34 37