

SECTION 17460

POWER SUPPLIES AND DISTRIBUTION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes requirements for Power Supplies and Power Distribution for Station communications.

1.02 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI):
 - 1. C2 National Electrical Safety Code
 - 2. C62.41 Recommended Practice on Surge Voltage in Low Voltage Power Circuits
- B. California Electric Code (CEC)
- C. Federal Communication Commission (FCC):
 - 1. FCC Rules and Regulations 47, Part 15, Subpart J Class A
- D. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. 446 Recommended Practices for Emergency Standby Power System for Industrial and Commercial Applications
 - 2. 519 Recommended Practices and Requirements For Harmonic Control in Electrical Power Systems
 - 3. 1100 Powering and Grounding Sensitive Electronic Equipment
- E. International Electrotechnical Commission (IEC):
 - 1. 60068-1 International Electrotechnical Commission
 - 2. 801-2 Electrostatic Discharge
- F. National Electrical Manufacturers Association (NEMA):
 - 1. NEMA 5 Receptacle Classification
- G. National Fire Protection Association (NFPA):
 - 1. 70 National Electric Code (NEC)
 - 2. 75 Standard for Protection of Electronic Computer/Data Processing Equipment

3. 101 Life Safety Code
 4. 130 Standard for Fixed Guideway Transit and Passenger Rail Systems
 5. R1-2 General Purpose and Communication Battery Chargers
- H. Underwriters Laboratories, Inc. (UL):
1. 1449 Safety Standard for Surge Protective Devices
 2. 1778 Standards for Uninterruptible Power Supply Systems

1.03 SYSTEM DESCRIPTION

- A. Design, provide, install and test Alternating Current (ac) and Direct Current (dc) power supplies for communication equipment in communications facilities and Distribution Cabinets (DC) as described in the Specifications.
- B. Provide and install all power distribution related cables in accordance with the Specifications.
- C. Provide and install grounding for all power supply equipment in accordance with the Specifications.
- D. Surge Arrester and Surge Suppression equipment size, type, installation and connection shall be in accordance with the Contract Drawings, NEC and CEC.
- E. Configure each UPS network and alarm configuration settings to report UPS and other subsystems' alarms (sensed by UPS dry contact inputs) to the CCF UPS Alarm Monitoring System. Coordinate with the Engineer end-to-end testing and reporting of such alarms at CCF.

1.04 SUBMITTALS

- A. Refer to Section 17000, Basic Communications Technical Requirements, for related and additional submittal requirements.
- B. Preliminary Design Technical Requirements: Include the following information as part of the PDR submittal package for the Power Supplies and Distribution:
 1. Manufacturer Data Sheets for Uninterruptible Power Supply (UPS), including batteries, battery charger, transformer, transfer switch, inverter and converter.
 2. Manufacturer Data Sheets for DC Power Supplies.
 3. A description of the power supply for each equipment site, including pertinent parameters from below:
 - a. Configuration including dimensions, plan and elevation
 - b. Power draw

- c. Standby time
 - d. Battery dimensions and weight
 - e. Short circuit rating
 - f. Voltage
 - g. Continuous Current
 - h. Interrupting Ratings
4. Schematic diagram of UPS components including, but not limited to the ac to dc converter, batteries and battery charger, inverter, transformer, transfer switch and ground connections.
5. Caltrain LAN Network and software configuration settings for UPS for communications with the existing Caltrain UPS Alarm monitoring head-end at CCF. UPS internal software alarm configurations and settings. UPS dry contact software and hardware configuration for external subsystem's alarms sensing and reporting.
6. Drawings showing the layout and rack mounting details of the Power Supply and UPS equipment.
7. Detailed drawings of connections to Main Grounding Buss-bar (MGB) showing routing of ground wires and mechanical details of connections.
8. Single line diagrams for Communications Equipment Room (CER) and Distribution Cabinets (DC) and station field wiring.
9. Calculations for each power supply demonstrating the capability of the proposed equipment to adequately serve the load demands of the connected equipment:
- a. Submit ac and dc power calculations based on the total peak and nominal load for each communications equipment and power distribution board.
 - b. Nominal load is defined as the load for normal operation. Include 50 percent factor for future expansion.
 - c. Derive load by showing power consumption of each type of device in each location (communications room and at each station distribution cabinet).
 - d. Identify a nominal load for each UPS based on normal direction operations.
 - e. Voltage drop calculations between the communications room and distribution cabinet panels.

- f. Calculations showing that the UPS electrical size can meet the peak load (including additional 50 percent capacity for future growth).
 - g. Calculations showing that the UPS battery capacity can sustain the nominal UPS load plus 50 percent (for future growth) for a period of 90 minutes
 - h. Structural and Seismic calculations for UPS, batteries and Power Distribution equipment mounting based on the dimensions and weight of the proposed components.
 - i. Calculations shall be signed/sealed by appropriate Professional Engineer licensed in the California.
- C. Final Design Technical Requirements: Include the following information as part of the FDR submittal package for the Power Supplies and Distribution:
 - 1. Updated PDR information. All drawings, calculations and design shall reflect a final design.
 - 2. Final and detailed wiring drawings ready for construction and installation.
 - 3. Final equipment list.
 - 4. Final equipment installation details.
 - 5. Final cable and equipment ID.
- D. Installation Plan: Submit the following installation document for each site no later than 60 days prior to the scheduled installation activity:
 - 1. Step-by-step plan for installing each piece of equipment, interconnecting raceway and cabling details, including estimated time required for the installation.
- E. Calculations and Certifications:
 - 1. Calculations as listed in the Preliminary Design and Final Design.
 - 2. Certifications: Copy of the following certifications shall be included:
 - a. ISO certification for all proposed manufacturers
- F. Product Samples: Submit and demonstrate product samples when requested by the Engineer.
- G. Test Plan and Procedures: At least 30 days in advance of testing, submit Test Plan and Procedure. Include tests to be made, format and layout of the test forms and report, and the limiting values to be used. In accordance with the format and requirements described in these Specifications, as a minimum, submit the following plan and procedures to satisfy the Power Supplies and Distribution testing requirements.

1. Test program plan: Include all the required information for the communications Power Supplies and Distribution in the Test Program Plan as outlined in these Specifications.
 2. Factory and Inspection Test Procedure: Submit a complete factory test and inspection procedure to satisfy requirements outlined under "Testing" herein.
 3. Field Test Procedure: Submit a complete field test procedure to satisfy requirements outlined under "Testing" herein.
 4. End-To-End Acceptance Test: Coordinate with Caltrain Engineering and perform end-to-end testing of each UPS's internal software and external subsystems' dry contact alarm reporting at CCF UPS Alarm monitoring software head-end.
- H. Test Records: Submit the Test Records and Results for review one week after the completion of each test, in accordance and format in these Specifications.
- I. Manufacturer Qualifications: Submit qualifications for any manufacturer differing from those specified herein and obtain Engineer's prequalification and approval. Acceptability of the manufacturer shall be based on the manufacturer's experience, qualifications, certifications (i.e. ISO-9001), equipment reliability, compliance with standards specified herein, and full compatibility with Caltrain's existing systems.
- J. As-Built Documentation: Submit complete As-Built documentation (including equipment O&M manuals and UPS final network, software and hardware configuration settings) and drawings, as specified in Section 17000, Basic Communications Technical Requirements, for communications Power Supplies and Distribution.

1.05 QUALITY ASSURANCE

- A. Contractor's fabrication, inspection, installation and testing shall comply with all applicable Standards and Codes as listed herein. All equipment and methods shall comply with the latest version of the standards as applicable in paragraph 1.02, Reference Standards.
- B. Material and Workmanship Requirements:
1. All equipment provided under this Section shall be UL listed.
 2. All grounding and lightning/surge protection equipment shall be in accordance with local standards and these specifications except as modified herein. Each piece of equipment shall be grounded and protected in accordance with the recommendations of the manufacturer.
 3. Use not discontinued product models, refurbished equipment, products at their end-of-life, end-of- sale, or end-of-service.

4. All products specified herein shall be subject to the Engineer approval based on the Contractor's ability to demonstrate adherence to the specified requirement and Engineer's approval of the manufacturer's quality process.
5. Any manufacturer differing from those specified herein shall require the Authority prequalification and approval. Acceptability of the manufacturer shall be based on the manufacturer's experience, qualifications, certifications (i.e. ISO-9001), equipment reliability, and compliance with standards specified herein, and full compatibility with the Caltrain's current system.

PART 2 - PRODUCTS

2.01 GENERAL DESIGN REQUIREMENTS

- A. Uninterruptible AC Power Supply:
 1. This type of power supply shall be utilized to provide conditioned ac power to equipment during normal operation and to provide temporary backup ac power in case of a failure of normal ac.
 2. UPS shall be provided at Communications Equipment Room (CER), and extended to each subsystem Distribution Cabinet (DC).
 3. Batteries shall provide 90 minutes of backup power at all station communication essential subsystems, and devices (i.e. WAN/LAN equipment, PA, TVM, Clipper Equipment, CCTV, VMS signs, etc.). Station non-essential devices such as maintenance power outlets, cabinet lighting, etc. shall be powered by non-UPS backed power.
 4. The UPS shall be initially sized for full system load plus 50 percent future capacity.
 5. UPS shall be equipped with by-pass switch of mechanical or solid state type, which shall provide automatic failover to the ac power source in the event of UPS output failure. Ac power source shall remain available, even if there has been a short in the UPS. The by-pass switch shall isolate the UPS rectifier and inverter components for replacement or service.
 6. Manual Bypass Switch: In addition to the automated by-pass switch, 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 for maintenance purposes. Such maintenance 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.
 7. UPS shall initiate an audible alarm upon activation of the automated or manual by-pass. The audio alarm shall be capable of being muted by the user. The alarm shall continue to sound while in by-pass mode. This shall

provide reminder to the user that load continues to be powered from utility or generator supply alone.

B. Dc Supply:

1. DC supplies (24Vdc) (and, if required, other power supplies) shall be provided and installed for Clipper CID devices, Media Converter and/or other devices (as required by the Contractor's design approved by the Engineer).
2. Power supplies shall provide DC power to equipment during normal operation. All dc power supplies used for communications equipment shall receive power from a UPS power source.

C. Ac Power Supply:

1. Primary ac power for the Communications Equipment Room (CER) shall be provided either from a Station Electrical Panel.
 - a. One 208 Vac, 3 phase circuit (or, if necessary, as per the Engineer approved alternative power source) appropriately sized shall provide power to the CER's UPS (line side).
 - b. AC power distribution within the CER and Station for subsystems shall be in accordance with Contract Drawings.
2. AC Power for Station subsystem Distribution Cabinets (DC) shall be provided from the CER's UPS (equipment side) and distributed as shown on the Contract Drawings.

Provide and install all required cables, distribution panels and connections between the CER's UPS electrical enclosure panel and the Distribution Cabinets.

D. Grounding:

1. Equipment within the CER and Distribution Cabinets shall be grounded to the communications MGB and CGB respectively, independent of the power supply ground or neutral connections.
2. The safety ground for UPS shall be bonded to the building MGB via the communications MGB to provide a single point earth ground.

2.02 UPS SYSTEM

- A. Each UPS system shall be sized to handle 150 percent of the station connected load (initial "day-one" load plus 50 percent spare for future growth). The backup time shall be 90 min for such load.
- B. Each UPS shall include a Ferro resonant transformer, battery float charger, batteries, static inverter, and microprocessor controlled switch circuitry.

1. The load shall normally be powered from the secondary of the Ferro resonant transformer; the primary of the transformer shall normally be powered from one of 120/208/240 Vac, 60 Hz sources from a station electrical power panel.
 - a. Manual bypass switch shall be provided and installed for the UPS such that the load can be powered from the normal source for maintenance without service interruption.
 - b. Manual ac Disconnect Switch shall be provided to facilitate disconnecting the equipment for maintenance service.
 - c. In the event of a UPS failure, the load shall revert to the normal ac source (even if that source is unavailable).
 2. The static inverter shall normally be off, but shall be switched on automatically upon detection of a failure or irregularity in the normal power input and shall then supply power to the transformer primary. The batteries shall power the inverter.
 3. The batteries shall be maintained at full charge by the battery charger. The battery charger shall be powered from the normal ac source in parallel with the transformer primary.
 4. The microprocessor controlled switch circuitry shall monitor the ac input and output and the dc voltage and current levels. Switching from normal to battery power and back to normal shall be automatic and shall not affect output voltage and current waveforms.
- C. Each UPS system shall provide power quality consistent with the equipment connected. In addition, the UPS shall meet or exceed the following specifications:
1. Input Voltage: 240/120 Vac (if approved by Engineer, 480 Vac), Nominal
 2. Output Voltage: 120 Vac, Nominal
 3. Voltage Regulation: ± 3 percent with input 96Vac to 138 Vac
 4. Spike Attenuation: 2000:1 (up to 6000 V and 200 A)
 5. Noise Attenuation: 120 dB Common Mode, - 60 dB Transverse Mode
 6. Output Frequency: 60 ± 0.005 Hz
 7. Waveform Type: Sine wave
 8. Input ac Overload Capacity: 125 percent Rated (10 Min), 150 percent (Surge)
 9. Output Waveform Distortion: 3 percent (Max) Single Harmonic, 5 percent Total Harmonic Distortion

10. Operating Temperature: 0 degrees to 40 degrees Celsius
 11. Operating Humidity: Up to 95 percent Relative Humidity (R.H.)
 12. Line Powered Efficiency: 88 percent average with a minimum of 90% efficiency above 50% load.
 13. Audible Noise: 51 dBA at 1 meter from the UPS surface.
 14. EMI Suppression: The UPS shall meet the FCC rules and regulation 47, part 15, subpart J, for class A devices
 15. Mean-Time-Between-Failures: 100,000 Hours
 16. Transfer time from line power to internal battery: 3-4ms
 17. The UPS system shall be equipped with intelligent battery management. This shall include remote management, alarm notification, dry contact alarm input sensing and environmental monitoring capability. The management system shall support SNMP protocol. The management system shall utilize a networking card configured for reporting sensed alarms to the CCF UPS Monitoring head-end over the Caltrain network.
- D. Transformer: The Ferro resonant transformer shall provide complete isolation from input to output. It shall be rated for continuous supply of 140 percent of the maximum draw of the communications equipment with input voltages in the range 96 to 138V.
- E. Inverter: The inverter shall utilize all solid state components and be rated for 140 percent of the continuous output required such that the transformer coupled output, as specified above, shall be realized when the inverter is on. There shall be no interruption of service to the load when the inverter is switched on or off.
- F. Batteries: The battery shall be a multi-cell bank composed of sealed maintenance free cells. The battery bank shall be rated to provide power to the inverter such that 140 percent of the current draw of the protected equipment can be provided upon complete failure of the ac input for a period specified in under "Uninterruptible ac Power Supply herein. The battery life shall be at least 200 charge/discharge cycles and 10 years.
- G. Battery Charger: The battery charger shall utilize all solid state components and shall be rated to fully charge the batteries within four hours from a fully discharged state while the normal load is connected. The battery charger shall include automatic tapering and floating controls.
- H. Microprocessor Control: The microprocessor control and switching circuitry shall continually monitor the ac input voltage, current, and frequency. If one of these parameters is outside the range where the output voltage or frequency remains within the specified tolerances, the inverter shall be switched on-line within eight milliseconds and the ac line disconnected. If the AC input comes back within range, the inverter shall be disconnected and the ac line re-connected automatically.

I. Light Emitting Diode (LED) indications for the following shall appear on the front panel of the unit: ac Line, Ready, Charging, Battery Power, and Alarm. In addition, the following functions shall be available on a keypad with Liquid Crystal Display (LCD) that shall be mounted on the front panel of the UPS, plugs into a diagnostics output port and are also functions of the TCP/IP SNMP monitor:

1. Meter Functions:
 - a. Ac Volts Output
 - b. Ac Volts Input
 - c. Battery Voltage
 - d. Ac Current Input
 - e. Ac Current Output
 - f. VA Load
 - g. Dc Current Input
 - h. Frequency
 - i. Heat Sink Temperature
 - j. Projected Run Time Available
 - k. Log of Power Outages and Alarms
2. Alarm Messages:
 - a. Low Battery
 - b. Near Low Battery
 - c. High Battery
 - d. Low Run Time
 - e. Low ac Output
 - f. High ac Output
 - g. Output Overload
 - h. Ambient Temperature High
 - i. Heat Sink Temperature High
 - j. Transformer Temperature High

- k. Check Battery
 - l. Check Inverter
 - m. High ac Input
 - n. Alarm Test
 - o. Detection and reporting of other subsystem's alarms reported through dry contact input terminals
3. Operating Modes:
- a. Off
 - b. Automatic
 - c. Line Conditioning
 - d. Inverter On
4. Set Operating Parameters:
- a. High ac Voltage
 - b. Low ac Voltage
 - c. High Battery Voltage
 - d. Low Battery Voltage
 - e. Near Low Battery
 - f. High Ambient Temperature
 - g. Frequency Tolerance
 - h. Battery Capacity (run time)
- J. Relay Alarm Contacts: Each UPS shall include two sets of alarm contacts (2 NO and 2 NC) rated at 125 Vdc and 1 Amp. The following outputs shall be programmed for future reporting of UPS alarms to the future Remote Terminal Unit (RTU) equipment, at the corresponding Communications House or Facility.
- 1. UPS Trouble: This relay shall change state when any of the parameters listed above move beyond the pre-established range. In addition, any faults with the battery chargers, batteries, or inverters shall cause this alarm to activate.
 - 2. Loss of Primary ac: This relay shall change state when the primary AC power is lost and reset when it is restored.

2.03 DC POWER SUPPLIES

- A. Communications Cabinet:
 - 1. When applicable, 24V dc power (i.e. Clipper CID devices, Media Converters, etc.) shall be provided in the following configuration:

Two power supplies each sized to provide 100 percent of the maximum design load, which shall be 125 percent of the actual load. Each power supply shall power an individual fuse and be located in each communications cabinet requiring dc power.
- B. The DC Power Supplies shall be powered by the UPS backed supply, as identified in the Contract documents.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Each power supply, including batteries shall be provided and installed as shown on the Contract Drawings.
- B. All cabling from the power supplies to communications equipment and the power panel shall be routed as Engineer approved and so as not to interfere with other cables or equipment.
- C. All cabling from the AC breaker panel to the power supply, where both are located within the same building, shall be installed within Electrical Metal Tubing (EMT) conduit.
- D. Install DC and uninterruptible power supply equipment as recommended by the manufacturer, and provide anchorage / seismic supports and restraints in accordance with the requirements as specified in these Specifications and as per Engineer approved Design.
- C. Grounding:
 - 1. General Equipment Grounding: Within each Communications Equipment Room (CER) and Distribution Cabinet, the power supply shall be grounded to the CMGB and CGB per this Specification. A power source neutral lead shall not be used as a ground.
 - 2. Power Supply Grounding: The safety ground for all UPS and power supplies shall be bonded to the CMGB or CGB per these Specifications and the Contract Drawings.

3.02 EQUIPMENT MOUNTING

- A. Cabinets and Racks:
 - 1. The UPS components, exclusive of batteries shall be mounted within a freestanding cabinet with removable panels. The cabinet shall include a ventilation opening for convection cooling such that the unit shall

operate within the specified temperature range. The cabinet shall have an enamel finish, in a color that shall be Engineer approved.

2. Equipment racks for mounting 19 inch EIA Standard equipment shall be in accordance with these Specifications.
 3. Install uninterruptible power supply equipment at locations indicated with the top of the monitor panel not more than 6 feet above the floor and the bottom not less than 12 inches above the floor, unless specifically indicated otherwise. If necessary, line up tops of trims to present neat appearance.
 4. UPS Systems mounted in 19 inch two post racks shall require additional support at the end of the system not bolted into the rack. Where necessary, angled braces shall be utilized (as per approval of Design by the Engineer).
- B. Battery Racks: The batteries shall be mounted in a rack, or as recommended by the battery manufacturer. The battery rack shall be made of channel steel with an acid resistant gray paint finish. The battery racks shall allow access to all battery terminals without removing batteries from the rack.
- C. Power Plug Mold Strip - Equipment Cabinets: Provide the required sized and rated UL power plug mold strip in each equipment rack or cabinet. The power plug mold strip shall be powered from the UPS Ac source that is shown on the Contract Drawings. The plug mold strip shall be mounted vertically in the cabinet and contain a minimum of 10 power outlets.
- D. Standard (non-UPS) Power Source - Equipment Cabinets:
1. Quad receptacles home run from the non-UPS Ac power source shall be installed in equipment racks or cabinets to provide access for non-essential or battery powered equipment such as test equipment or laptop computers.
 2. One, 120Vac, 20A, duplex receptacle will be provided from the non-UPS ac power source to each communications cabinet for general purpose use.
- E. UPS Receptacle Type:
1. One, 120Vac, 30A, duplex receptacle rated NEMA L5-30R (twist lock) will be provided in each field communications cabinet for UPS to be used for communication equipment use only (not for general purpose use).
 2. One, 120Vac, 30A, duplex receptacle rated NEMA L5-30R (twist lock) will be provided for each CER communications equipment rack or cabinet for UPS to be used for communication equipment use only (not for general purpose use).
- F. Grounding Wire: Ground wire shall be a minimum of No. 6 AWG, or as specified on the Contract Drawings, stranded copper wire with insulating jacket. The insulation shall be rated for 600V minimum, and shall be colored green.

- G. UPS Distribution Panels: 120Vac UPS Distribution panels will be placed throughout the station per the Contract Drawings to distribute UPS power to assigned subsystem equipment. These panels will be typically rated at 100A to 225A (rated as per the Engineer approved Design power calculations) with 16 to 30 breaker positions. UPS Distribution panels will be fed from the UPS Main Distribution Panel located in the CER.

3.03 TESTING

- A. Testing of each power supply shall be conducted in accordance with these Specifications. Tests shall verify the following:
 - 1. Output Power Levels
 - 2. Output Quality
 - 3. Transfer of load to standby source
 - 4. DC equipment holdup in the event of single rectifier failure
 - 5. Backup power holdup times under full load with commercial line power removed
 - 6. Accuracy of all meters
 - 7. Proper grounding and protection connections and levels
 - 8. Functionality of all alarms, indications, and controls
 - 9. All Station systems functions which depend on the UPS shall be tested while the UPS system is operating on the backup battery 15 to 30 minutes after the UPS has switched to its battery source.
- B. Provide all instruments, materials, and labor required for tests specified.
- C. Follow the test equipment manufacturer's instructions as to operation and electrical connections.
- D. System Integration Test (SIT): Provide qualified staff to support this test as described. SIT will be directed by the Engineer. SIT requirements for power systems are generally related to integrating power system alarms.

END OF SECTION