

## **SECTION 17160**

### **OUTDOOR COMMUNICATIONS CABINETS**

#### **PART 1 - GENERAL**

##### **1.01 DESCRIPTION**

- A. Section describes requirements for outdoor communications cabinets associated with station networks and subsystems, including design of cabinets.

##### **1.02 GENERAL**

- A. Typical Station Communication design involves two major equipment housing locations. They are:
  - 1. Communications Equipment Room (CER) which may be a prefabricated shelter or house or may be an environmentally and access controlled space within the station building structure. This space houses the main communications equipment with direct access to the carrier network. The equipment cabinets used in the CER are described in Section 17050, Basic Communications Equipment, Materials, and Methods.
  - 2. Distribution Cabinets (DC) are outdoor rated enclosures located throughout the station, which house network equipment for direct subsystem connectivity. Main requirements for the Distribution cabinets are included within this section. Section 17050, Basic Communications Equipment, Materials, and Methods provides for additional requirements for the Distribution cabinets.
- B. Non-typical Station Communication design may include the following types of equipment locations as specified in this Section:
  - 1. Communications Interface Cabinet (CIC) is an outdoor rated cabinet to house the main communications cabinet. A CIC is also sometimes referred to as a Station Communications Cabinet (SCC). In this Section the term 'CIC' will be used further on. CIC is used for temporary station construction and in lieu of other environmentally and access controlled space such as the CER. This cabinet shall be rated for outdoor use and be the large enough to house all the station or facility main communications equipment.
  - 2. Field Communications Cabinet (CC) is a small outdoor rated enclosure capable of housing subsystem network components and cable terminations. Unlike a Distribution Cabinet (DC), CC is used at a subsystem device where standard distribution topology is not possible. CCTV camera located greater than 328 feet from the nearest DC is an example of when a CC at the subsystem device shall be used.

**1.03 REFERENCE STANDARDS**

- A. ASTM International (ASTM):
  - 1. B3 Specification for Soft Annealed Copper Wire
- B. National Fire Protection Association (NFPA):
  - 1. 70 National Electric Code
  - 2. 130 Fixed Guideway Transit and Passenger Rail Systems
- C. National Electrical Manufacturers Association (NEMA):
  - 1. 250 Enclosures for Electrical Equipment (1000 Volts Maximum)
  - 2. ICS-1 General Standards for Industrial Control and Systems
  - 3. ICS-4 Terminal Blocks
  - 4. ICS-6 Industrial Controls and Systems Enclosures
  - 5. FB1 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit and Cable Assemblies
  - 6. VE1 Metallic Cable Tray Systems
  - 7. WC 7 Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
  - 8. WD 1 General Requirements for Wiring Devices
- D. California Electric Code (CEC)
- E. National Electrical Contractors Association (NECA):
  - 1. Standard Practices for Good Workmanship in Electrical Construction
- F. Telecommunications Industry Association (TIA):
  - 1. TIA/EIA-568-B.1-2 Commercial – Building Telecommunication Cabling Standard
  - 2. TIA/EIA-J-STD-607 Commercial – Building Grounding and Bonding Requirements for Telecommunications
- G. Underwriters Laboratories, Inc. (UL):
  - 1. 50 Enclosures for Electrical Equipment – Nonenvironmental Considerations
  - 2. 50E Enclosures for Electrical Equipment – Environmental Considerations

3. 497 Protectors for Paired Conductor Communication Circuits
4. 508 Industrial Control Equipment
5. 514A Metallic Outlet Boxes
6. 514B Conduits, Tubing and Cable Fittings
7. 969 Marking and Labeling Systems
8. 1059 Terminal Blocks

#### **1.04 SYSTEM DESCRIPTION**

- A. Provide the type of outdoor communications cabinets indicated in the Contract Documents.
- B. Provide and mount the following equipment inside the Communications Cabinet (CC) per the Contract Drawings. Depending on the type of cable connectivity (copper or fiber), the following equipment shall be included:
  1. Fiber or copper cable termination panel
  2. Fiber or copper media converter(s)/switch(es)
  3. DC power supply if applicable
  4. Terminal or protection blocks (copper cabling and/or any outdoor cabling with conductive materials)
  5. UPS and general purpose ac receptacles
  6. Grounding Equipment
- C. Provide and mount the following equipment inside the Communications Interface Cabinet (CIC) as associated with the stations main network communications. Include the station communication network interfaces which connect the station to the OCC via leased or owned network transport facilities:
  1. Fiber termination and splice panels
  2. Audio switch/amplifier/controller/microphone(s) for PAS
  3. UPS power supply and distribution
  4. Network Data Switches, CSU, or channel banks
  5. Clipper CID Equipment
  6. Phone Equipment
  7. Terminal or protection blocks for MPOE and any outdoor cabling with conductive materials

8. Cable Management equipment
  9. Grounding Equipment
- D. Provide and mount the following equipment inside the Distribution Cabinet (DC) as associated with the stations main network communications:
1. Fiber termination and splice panels
  2. UPS power supply (where required) and distribution
  3. Network Data Switches, CSU, or channel banks
  4. Clipper CID Equipment
  5. CID Power Supplies
  6. Terminal or protection blocks for any outdoor cabling with conductive materials
  7. Cable Management equipment
  8. Grounding Equipment
- E. Provide termination and electrical protection for all copper power, indication, control, audio, and communications cables that enter the CC, DC and CIC (where applicable).
- F. Provide Heating, Ventilation and Air Conditioning (HVAC) to maintain the temperature as specified in this Specification, under the ambient conditions specified in this Section (as required by each cabinet's design thermo calculations approved by the Engineer).

#### **1.05 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 Preliminary Design subsystem package for the DC, CC and CIC:
1. Drawings showing the communications cabinet dimensions, layout (plan and elevations).
  2. All calculations including heating/cooling (thermo calculations) and power requirements. Thermo calculations shall show that the equipment mounted inside the cabinet for will operate without overheating and within their vendor-specified operational environmental range for ambient conditions specified in these Specifications. Submit seismic calculations to show compliance with the requirements of these specifications.

3. Equipment arrangement (including dimensions), for all equipment racks or surface mounted equipment and weight of equipment and major components.
  4. Cable and conduit Entrance/Exit details including ID (tagging).
  5. Grounding arrangement.
  6. UPS and general purpose AC receptacle location and amperage.
  7. Product specifications for HVAC equipment (where required), intrusion device, MDF, wiring blocks and circuit protection.
  8. External Interface Details for Power Connections.
  9. Door arrangement.
  10. Mounting locations and supports for equipment mounted in the cabinets and/or enclosures.
  11. Drawings showing space available for conduit entrance, knockout locations for routing and training of cables. Available space shall take into consideration bending radius requirements of cables.
  12. Control schematics and relay logic with full narrative description of the control logic with reference to the device, relays, timers, contacts and components to be used for fabrication and installation.
  13. Complete internal wiring diagrams.
  14. Terminal strip designations.
  15. Wire numbers.
  16. Nameplates Schedule.
  17. Layouts and templates if anchoring in concrete (if required).
- C. Final Design Technical Requirements: Include the following information as part of the FDR submittal package for the DC, CC and CIC:
1. Updated PDR information. All drawings, calculations and design information 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 Work Plans: Submit the following installation document for each site prior to the scheduled installation activity in accordance with these Specifications. The installation Work plan shall include the following:
1. Drawings showing plan and elevation details of the foundation and the duct bank, including the interface with the manhole.
  2. Site plan information shall include specific layout (plan and elevation) and detailed grounding drawings for each DC, CC and CIC.
  3. Delivery and Installation Procedures and Inspection Sheets:
    - a. The procedures submitted shall include descriptions of the equipment used for transport and setting of the DC, CC and CIC, and shall include specific dates for installation.
    - b. Inspection Sheets shall be completed and submitted to the Engineer after installation of the DC, CC and CIC. The report shall include details of cable terminations and equipment wiring diagrams marked-up with as-wired conditions.
    - c. The installation drawings and procedures shall define the installation adequately and in sufficient detail, such that if the procedures are followed, the resulting installation shall meet approved standards, practices and procedures for workmanship, maintainability requirements, referenced installation standards and installation requirements defined within these Specifications and the Contract Drawings, and the installation requirements of local jurisdictions. If not, the installation drawings and procedures shall be revised prior to subsequent installations.
    - d. The installation drawings and procedures shall adequately provide for the safety of installation personnel. If not, the installation procedures shall be revised prior to subsequent installations.
- E. Calculations and Certifications:
1. Calculations as listed in the Final Design.
  2. ISO certification for all proposed manufacturers.
- F. Product Samples: Submit and demonstrate product samples when required by these specifications
- G. Test Plan and Procedures: In accordance with the format and requirements described in these Specifications, as a minimum, submit the following plan and procedures to satisfy the CC or CIC testing requirements:
1. Test program plan: Include all the required information for the DC, CC and CIC 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 all the requirements outlined in paragraph 3.02 of this Section.
  3. Field Test Procedure: Submit a complete field test procedure to satisfy all the requirements outlined in paragraph 3.02 of this Section.
  4. End-To-End Acceptance Test: Where used, conduct end-to-end testing of cabinets' intrusion alarms.
  5. System Integration Test: Provide qualified staff to support this test as described in Article entitled Testing and Inspection herein.
- H. Test Records: Submit the Inspection and Test Records and Results for review after the completion of each test, in accordance with format described 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, and compliance with standards specified herein, and full compatibility with Caltrain's existing systems.
- J. As-Built Documentation: Submit complete As-Built documentation and drawings, O&M and other manuals, as specified in Section 17000, Basic Communications Technical Requirements, for each DC, CC and CIC and contents.

#### **1.06 QUALITY ASSURANCE**

- A. Applicable Standards and Codes:
1. Fabrication, inspection, installation and testing shall comply with all applicable Standards and Codes as listed herein.
  2. All equipment and methods shall comply with the latest version of the standards.
- B. Material and Workmanship Requirements:
1. All equipment provided under this Section shall be UL listed.
  2. All grounding shall be in accordance with these Specifications, and with the recommendations of the equipment manufacturer.
  3. Use no 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 approval of the manufacturer's quality process (i.e. ISO-9001).

## PART 2 - PRODUCTS

### 2.01 GENERAL DESIGN REQUIREMENTS

- A. Physical Characteristics:
1. The DC, CC or CIC shall be a custom enclosure.
  2. Rated NEMA 4X and vandal-proof. Where HVAC is required (as the result of thermo calculations), it is acceptable to manufacture cutouts for mounting of air conditioning and fan heat exchange equipment, which will downgrade the initial rating of the outdoor cabinet from NEMA 4X to NEMA 3R. To maintain protection of the cabinet and its equipment against water, moisture and other elements, use the heat exchange equipment vendor recommendations regarding types of gaskets and other methods required to seal any potential openings as a result of installation of such equipment on the side of the outdoor enclosures. The Engineer can consider acceptance of use of enclosures with initial NEMA 3R rating as long as they provide for the same corrosion and vandal-proof protection as described in this paragraph above.
  3. Minimum dimensions: Minimum cabinets' dimensions below shall be adjusted to accommodate the actual project equipment and shall also account for 50% of spare space (for future growth):
    - a. CIC shall be 72 inches (Wide) x 96 inches (High) x 36 inches (Deep)
    - b. CC shall be 20 inches (Wide) x 24 inches (High) x 8 inches (Deep)
    - c. DC shall be 24 inches (Wide) x 48 inches (High) x 30 inches (Deep)
  4. As (and if) required by the thermo-calculations (calculated equipment BTU load), the cabinets shall be equipped with a ICE QUBE IQ8000VHA, IQ10000V or IQ12000V air conditioner/heater or Engineer approved equal. To ensure the HVAC units are vandal proof and to protect fan openings and outside controls, the units above shall be equipped with the appropriate additional protective equipment such as Washdown Hoods, Remote Controllers, etc.
  5. The CIC shall have two doors on the front side and two doors on the rear side.
  6. The DC shall have a front side door and a back side door.
  7. Doors shall provide seal via foam-in-place gasket, and shall be hinged and equipped with a 3-point lockable handle.
  8. DC, CC and CIC shall be fabricated from 12-gauge stainless steel.
  9. MDF shall be provided within the CIC for cable termination and circuit protection in accordance with these Specifications, and the Contract Drawings.



10. FDP shall be provided with a maximum of 72 connections for termination of single-mode fiber cables. Refer to Section 17250.
  11. Lexan Polycarbonate panels, 3/4" thick, painted white in accordance with this Section, shall be provided for mounting manual disconnect switches, MDF, and cross-connect terminal block.
  12. The Contractor shall install standard EIA- 310D racks in the DC and CIC. Racks shall be zinc-plated steel and located so that equipment does not interfere with cable path to the MDF. Blank panels shall be provided and installed in locations where equipment is not present; as depicted in the Contract Drawings
  13. Where access to rack-mounted equipment is not convenient from either the front or rear, a zinc-plated steel pullout shelf shall be provided for that equipment.
  14. A zinc plated steel pull out shelf shall be provided for supporting a local VMB input device.
  15. UPS support hardware shall be provided.
  16. A UL approved rack-mounted power strip and light bulb holder (with light bulbs) shall be provided for each door side of the DC and CIC. The light bulbs shall be protected with a heavy duty wire cage.
  17. All cables routed within the DCs or CIC shall be organized and routed in conduit or flex tube for cable protection. The cabinets shall utilize the appropriate cable management hardware.
  18. The inside cabinet (DCs and CIC) floor shall be at least 6 inches above the concrete pad on which the cabinet is located.
  19. Power line filter shall be provided for improvement in processor immunity to high frequency noise. Ferrite sleeve shall also be provided for incoming AC power cable to reduce electromagnetic field interference.
- B. Painting: Internal DC and CIC members (such as racks, cable tray, panels) that are not stainless steel shall be painted black with corrosion inhibiting paint. Refer to Section 17050, Basic Communications Equipment, Materials, and Methods, for product descriptions.

## 2.02 HVAC

- A. Where required by thermo-calculations, a DC or CIC shall be equipped with a thermostatically controlled heater, sized to maintain the cabinet's internal temperature above 50 degrees F with ambient temperatures as specified in these Specifications.
- B. The HVAC unit shall be sized to provide 50% more cooling capacity than initially required by the installed equipment.

- C. Cabinets shall be equipped with an air conditioner, which shall provide cooling when the internal temperature rises above 85 degrees F. The cooling device shall be sufficient to maintain cabinet temperature below 100 degrees F, with ambient conditions as specified in these Specifications. The air conditioner condensation drain tube shall be installed. It is acceptable for cabinets to operate at higher temperatures, as long as the Contractor-chosen equipment is specifically manufactured for such high temperature operations. For such equipment, the Engineer can consider Contractor exclusion of HVAC equipment (or downgrade cooling to use of fans only), if the Contractor can demonstrate with thermo calculations (including 50% future spare capacity) that equipment inside the cabinets will operate within its operational environmental parameters for the ambient temperatures as specified in these Specifications.
- D. Any vents shall include vandal resistant 12-gauge wire mesh screens and rain hoods (wash down) designed to prevent vandalism and prevent horizontally driven windblown rain from entering the cabinet.
- E. The HVAC temperature controller shall provide an adjustable high/low temperature alarm. Alarm contacts shall be hardwired to the MDF for monitoring.
- F. To prevent vandalism, the temperature controllers shall be implemented inside the cabinet. If necessary, a remote controller option shall be used..
- G. The HVAC system shall be optionally equipped with remote control via Ethernet with the approval of the Engineer.

### **2.03 CABLE ENTRANCES**

- A. CIC and DC concrete base shall be sealed with fire stop in accordance with these Specifications including around the conduits where they leave the base to stop moisture and fire.
- B. The conduit/CIC/DC joint shall be completely sealed where the conduit penetrates the cabinet bottom. After all cables have been installed, conduit openings shall be filled with duct sealant in order to stop moisture and fire.

### **2.04 VANDAL PROTECTION AND SECURITY**

- A. Steel plates shall be installed as backing to the lockset or hasp.
- B. Provide locks for each DC, CC and CIC so as to secure the entire cabinet. The locks shall have locking cylinders that match those used for other cabinets used in the Caltrain's existing systems. Two keys shall be provided to the Engineer for each cabinet prior to project closeout.
- C. An exterior skirt located at the bottom of the DC/CIC between the cabinet floor and the concrete pad shall be provided. The skirt shall be attached with vandal resistant stainless steel fasteners, and be designed to prevent trash from blowing or being forced under the cabinet.
- D. The HVAC system shall be secured against easy access with ordinary tools.

**2.05 GROUNDING**

- A. CIC and DCs shall be equipped with two copper grounding buss bars (for Chassis and Telecommunications grounding) as specified in these Specifications. Buss bars shall be located in the bottom of the cabinet and be mounted on insulators that electrically isolate the cabinet from the buss bars (see Contract Drawings).
- B. The grounding buss bars shall each be bonded to a No. 4 AWG copper conductor, which shall be connected to a single point ground grid per Contract Drawings.
- C. CIC and DCs shall be equipped with a 3/8-inch high tensile strength bronze stud, which shall be connected to the chassis grounding buss bar using a No. 6 AWG conductor per Contract Drawings.
- D. Internal chassis grounding arrangement shall utilize No. 6 AWG insulated, stranded ground wire connected to the Cabinet Grounding Buss Bar (CGB) per site specific drawings.
- E. Ground wire from the station AC supply panel shall be grounded to the CGB using No. 6 AWG ground wire per site specific drawings.
- F. Protected Terminal Block ground shall be connected to the CGB using No. 6 AWG Ground wire per site specific drawings.
- G. All electronic equipment signal and telecommunications grounds shall be grounded, using No. 6 AWG insulated stranded copper conductors, to the Telecommunications Main Grounding Buss Bar (TMGB) per Contract Drawings.
- H. Shields from signal cables shall be grounded to the TGB in accordance and the Contract Drawings.
- I. Grounding not described above shall be in accordance with these Specifications.

**2.06 TERMINAL BLOCKS**

- A. Terminal blocks and Protected Terminal Blocks (PTBs) shall be as specified in these Specifications.
- B. Terminal block and PTB types and pair counts shall be in accordance with the Contract Drawings.
- C. The Protected Terminal Block shall provide protection of all communications cables outside the Station and Distribution cabinets against accidental and natural power surges.

**2.07 CIC AND DC CABINET LIGHTS AND INTRUSION ALARM**

- A. Provide an interior cabinet light on each side of the CIC or DC enclosure. Each light shall turn on when the corresponding door is opened and turn off when it is closed.

- B. Provide a simple intrusion detection circuit that shall utilize magnetic switches and be activated when any panel door is opened. Dual dry alarm contacts shall be wired to the MDF, cross-connected and terminated at the Communications Remote Terminal Unit (RTU), and reported to the Central Control Facility (CCF) via the Communications Transmission Subsystem (CTS) and UPS Dry Contact Alarm sensing (or, in the future, via Supervisory Control System (SCS)).

## **2.08 SOURCE QUALITY CONTROL**

- A. Notify the Engineer at least 21 days prior to these inspections.
- B. Perform a pre-installation inspection for defects and verify that the DC, CC and CIC shall physically and dimensionally support the DC, CC and CIC equipment. This inspection shall take place before the DC, CC and CIC leaves the factory.
- C. Factory Test and Inspection: Provide the Engineer with each test or inspection report after each test or inspection.
  - 1. Inspect the DC, CC and CIC at the Factory for cracks and other damage, and repair as required.
  - 2. Inspect the DC, CC and CIC at the Factory for level and plumb, proper operation of doors and locks, proper location and installation of HVAC equipment, and other miscellaneous equipment if applicable.
  - 3. Inspections shall verify:
    - a. Conformance to standards, methods, and quality.
    - b. Correct location, positioning, seating, mounting, orientation, and labeling.
    - c. Secured internal cable and wire connections.
    - d. Proper routing and termination of internal wire and cable.
    - e. Proper grounding of all equipment.
    - f. Correct and complete labeling and tagging of wire, cable, terminal, connectors and equipment.
    - g. Conformance to installation requirements.
    - h. Conformance to inventory data.
  - 4. Provide inspection results for the Engineer approval.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. DC, CC and CIC shall be installed at locations in stations as indicated on the Contract Drawings.

- B. DC and CIC Mounting:
1. Prior to mounting the cabinet, verify that the cabinet foundation, conduit stub-ups and anchors are correctly configured as per the Contract Drawings.
  2. Install the cabinet level and plumb on the cabinet manufacturer's provided support feet. Verify that all parts of the cabinet (including open doors) are outside the dynamic envelope of the trains.
  3. Plants, foliage, or other impediments shall be placed at least eight feet away from the installed cabinet.
  4. Provide a 3-foot wide concrete foundation for the CIC and DC or as shown in the Contract Drawings.
  5. After all cables have been installed and terminated, fill the conduit openings with an approved fire stop duct sealant to prevent fire and moisture from entering the cabinet.
  6. Seal the bottom of the cabinet, where the conduits penetrate, with an approved sealant to stop fire and moisture.
  7. Remove any auxiliary temporary equipment used for assistance of cabinet's installation.
- C. Cable Termination: Cables shall be dressed, tagged and terminated in accordance with these Specifications.
- D. All grounding and cable wiring shall be field installed, labeled, and tested for continuity.
- E. All equipment shall be installed according to Contract Drawings and manufacturer's requirements.
- F. Terminal blocks, PTB's and cross-connects shall be mounted to internal panels and shall be arranged as shown on the approved site specific drawings. Equipment layout and mounting shall be done such that Terminal block, and PTB equipment shall not be impeded or obstructed by other equipment and shall allow technicians to make moves, adds, and changes with ease.
- G. Contractor shall make all DC, CC and CIC equipment and MDF/terminal block connections, including all cross-connections, as shown on the Contract Drawings.
- H. All connections and cross-connections shall use required wire in accordance with these Specifications, and the Contract Drawings.
- I. DC, CIC and CC ac power shall be conditioned by UPS, capable of maintaining backup power to all AC powered CIC and CC equipment, for no less than 90 minutes under full load of all connected devices. Refer to Section 17460.
- J. Power strips with no less than eight receptacles shall be installed in each rack within the CIC to provide UPS power to rack-mounted equipment.

- K. Power strips shall be installed in accordance with Contract Drawings and oriented to provide the highest density of receptacles to the rear of rack-mounted equipment.
- L. Install a clear plastic document pouch attached to the inside door frame containing a detailed parts list inventory of all equipment contained in the CIC or CC, and also include as-built drawings or diagrams showing equipment interconnections, wiring, power connections, and equipment configurations.
- M. Once installation is complete remove any disposable installation materials including empty equipment containers, wrappers, wire fragments, or other items and thoroughly clean enclosure of dirt, dust, and all other contaminants.

### 3.02 TESTING AND INSPECTION

- A. Inspect the DC, CC and CIC for defects after it is installed in the field. This inspection shall verify proper installation and sealing of the DC, CC and CIC, and also ensure that there are no sharp edges that could pose a hazard to the public or the Engineer personnel.
- B. Check that all cables and wires are properly terminated and the terminations are correctly labeled.
- C. Perform the following inspections and tests on each DC, CC and CIC, where applicable. The Engineer shall be given written notification prior to each test and inspection.
- D. Provide testing and inspection submittals prior to each scheduled work for Engineer approval.
- E. Provide the Engineer with each test or inspection report after each test or inspection.
  - 1. Factory Test and Inspection: Refer to Source Quality Control herein
  - 2. Field Inspection:
    - a. Prior to installation, inspect the CIC and DC foundation, conduit stub-ups and anchors to verify that they conform to the Contract Drawings. Correct discrepancies prior to commencing cabinet installation.
    - b. Field inspection shall include inspection of the CIC and DC including lighting fixtures, intrusion sensors, equipment racks.
    - c. The inspection of the DC, CC and CIC installation shall confirm that:
      - i. Conformance to installation requirements
      - ii. Conformance to standards, methods and quality
      - iii. Proper routing and termination of wire and cable

- iv. Secured cable and wire connections
  - v. Proper grounding of all equipment
  - vi. Correct and complete labeling and tagging of wire, cable, terminal, connectors and equipment
3. Field Tests and Records: Perform the following field tests:
- a. Test the electrical continuity of the connections within the DC, CC and CIC by measuring the resistance from the line side to the equipment side for each conductor terminated within the cabinet.
  - b. Verify operation of main circuit breaker and all feeder circuit breakers.
  - c. Measure resistance to ground from all ground points, including those located in equipment cabinets. Measured resistance shall not exceed 3 ohms. Refer to Section 17060, Grounding of Communications Equipment.
  - d. Verify operation of all lighting.
  - e. Verify operation of HVAC equipment, including heaters, air conditioner, and all thermostatic controls.
  - f. Verify operation and reporting of all CIC and DC alarm indications both locally and at the UPS Alarm Dry Contact (or future Communications RTU) terminal block.
  - g. Verify operation of all equipment controls and indicators.
  - h. Verify that all cables and wires are labeled properly and all color codes have been observed.
  - i. Correct malfunctioning components on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - j. Provide records of all electrical tests for Engineer approval.
4. End-To-End Acceptance test: End-To-End testing shall be a part of other subsystem testing.
5. System Integration Test: Provide qualified technical staff to perform this test.

**END OF SECTION**