SECTION 17000
BASIC COMMUNICATIONS TECHNICAL REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section provides an overview of technical requirements, engineering guidelines, technical constraints, and general conditions to be followed throughout the design of the Station Communications System.

B. Technical requirements specific to each communications subsystem are in each of the subsystem Specification Sections within Division 17, Station Communications.

1.02 GENERAL

A. The provisions of this Section apply to all sections within the Division 17, Station Communications, except as otherwise specified. This and all other Specification Sections are collectively referred to Specifications.

1.03 REFERENCE STANDARDS

A. Building Industry Consulting Service International (BICSI):
   1. Registration as Communications Distribution Designer (RCDD)

B. Institute of Electrical and Electronic Engineers (IEEE):
   1. 200 Reference Designations for Electrical and Electronics Part and Equipment

C. Military Standard (MIL-STD):
   1. 472F Human Engineering

1.04 SUBMITTALS

A. Design Review Submittals - General Requirements

1. Submit Design Review Submittals consisting of a complete design description, including detailed drawings, specifications, and submittals of all subsystems and elements within the subsystem. If not governed by codes and regulations, as a minimum, calculation, test procedure, final drawing, and submittal shall be reviewed, signed and sealed by a BICSI Registered Communications Distribution Designer (RCDD). For submittals involving engineering design services required by governing codes and regulations; system design, load and design calculations shall be sealed and signed by a professional engineer, currently registered in the State of California, for the corresponding discipline. The final design document shall contain sufficient details for construction.
2. Include in each submittal phase all materials, equipment, assembly and installation required to carry out the functions and purposes indicated in the Specifications, and to make the system suitable for the purpose for which it is intended, whether or not such materials, equipment, assembly and installation are specifically indicated in the requirements of these Specifications.

3. The Engineer will not approve the proposed design that fails to achieve the result intended by the requirements of this Section or is not in accordance with sound engineering principles. Revise the design until it meets with Engineer approval in accordance with the requirements of these Specifications.

4. Approval or disapproval by the Engineer, or failure to approve or disapprove shall not relieve the Contractor of any responsibilities including the responsibility to provide a sound and practicable system design, suited for the intended purpose outlined in the Specifications and responsibility for accuracy and agreement of dimensions and details.

5. Coordinate each submittal with the requirements of the Work, placing particular emphasis upon assuring that each submittal of one trade is compatible with other submittals of related work. Ensure submittal is complete with all relevant data required for review, including, as a minimum the following:

   a. The correctness of the drawings, for shop fits and field connections, and for the results obtained by the use of such drawings
   b. Verification of catalog numbers, and similar data
   c. Determination and verification of field measurements and field construction criteria
   d. Checking and coordinating information in the submittal with requirements of the Work and of the Contract Documents
   e. Determination of accuracy and completeness of dimensions and quantities
   f. Confirmation and coordination of dimensions and field conditions at the site
   g. Safety precautions
   h. Errors or omissions on submittals
   i. Coordination and performance of work of all trades
   j. Identification of deviation(s) from Contract requirements

6. Approval of drawings and associated calculations by the Engineer shall not relieve the Contractor from the responsibility for errors or omissions
in the drawings and associated calculations, or from deviations from the Contract Documents, unless submittals containing such deviations were submitted to the Engineer and the deviations were specifically called to the attention of the Engineer in the letter of transmittal and within the submittal, and approved specifically by the Engineer as a Contract change.

7. Where requirements posed by individual subsystems, as defined in other Sections of these Specifications, are different or greater than those specified in this Section, those other requirements shall be deemed to augment the requirements specified herein. All requests for design variations and exceptions from specified standards must be submitted to the Engineer for review and approval.

8. Design Review requirements for each submittal: Preliminary and Final are defined within the individual subsystem Sections. Preliminary Design packages shall be individual submittals or each subsystem, where the Final Design package is one complete submittal sufficient to provide all the required details for construction, overall system integration, and operation. Requests for design variations and exceptions must be submitted not later than the Final Design review and approved by the Owner in writing before the affected Design Units could be released for construction.

9. Order the designated equipment and material only after Engineer’s approval of the individual subsystem Preliminary Design submittal, which includes design, calculations, operation as well as the entire product data for that subsystem.

B. Preliminary Design Technical Requirements

1. Submit Preliminary Design packages to satisfy the requirement outlined herein and the subject subsystem section of these Specifications. Communications Preliminary Design shall be required for the following subsystems, except for those subsystems which are not included in the Contract:

   a. Communications Facilities
   b. Communications Cabinets
   c. Conduit / Raceway / Ductbank Subsystem
   d. Communications Cable
   e. Power Cable
   f. Fiber Optics Cable Subsystem
   g. Public Address (PA) Subsystem
   h. Visual Message Sign (VMS) Subsystem
2. Each Preliminary Design package shall be organized to include the following headings and information:


b. Reference Material: List of relevant references and standards.

c. Specification compliance matrix table acknowledging and referencing the Contractor’s conformance to each technical requirement clause of every subsystem specifications Section.

d. Design Description: As a minimum shall include the subsystem description, detailed design and interface information, all performance, functionality and operational description, as well as details such as the cable and equipment identification.

e. Interface Requirements: Identify all required interfaces with other communications and non-communications systems and subsystems. The Preliminary Design shall include the following:

1) Interfaces between Work performed under this Contract and any other Communications contracts, such as, Rail Operations Control System (ROCS) and Passenger Information System located at the Central Control Facility (CCF), Alarm Points and any other required interfaces.

2) Interfaces between the subsystems defined under this Contract. Examples are PAS and LAN; WAN and LAN, TVM and LAN; all the other required interfaces defined in these Specifications.

3) Identification and description of any inquired hardware and software modifications or additions to existing subsystems equipment.

4) Identification of all external interfaces, including those to facilities and equipment provided by others. Interface
Examples include power, cable facilities, discreet signals, voice, and data; and the format/coding of the exchanged data.

5) Interfaces between the systems. This includes both Communications and Signals.

6) Interfaces between existing systems and Work performed under this contract, between subsystems and all other interfaces which include media converters and/or protocol converters shall be identified and described in detail.

f. Equipment List: Submit a table or list of model and part numbers for all proposed equipment and materials to be used for individual subsystems. Include the expected lead-time for each item while identifying in boldface type the ones with greater than 30 days. The table or list shall be grouped for each subsystem with functional descriptions of equipment or material included. Quantities and locations shall be included.

g. Product Data Sheet: Submit product information in sufficient detail to determine if the component meets these Specifications. The models to be used in the contract shall be explicitly identified in the product data sheet.

h. Calculations: Provide all the required signed and sealed calculations as outlined in the subject subsystem section.

i. Phasing and Cutovers: Identification and description of all major system cutover events or integration activities describing techniques, methods, duration and procedures.

j. Certifications, Registration, and Resumes: Provide a copy of all the required certifications, registrations and resumes as outlined in the subject subsystem section.

k. Drawings: Electrical, mechanical, block and functional diagrams with corresponding parts list.

C. Final Design Technical Requirements

1. Submit one complete Final Design package no later than 60 days after Engineer’s approval of all the Preliminary Design submittals. Obtain Engineer’s approval of all individual Preliminary Design submittals prior to submitting the Final Design submittal package.

2. The Final Design Submittal Package shall be organized to include the following final design information:

a. Engineer approved and updated versions of all previously submitted design review materials. Updated material shall represent complete design, final calculations; detailed product
and component level parts list, drawings, phasing and interface
details required for construction, intended network, software and
configuration settings. All the new and revised sections of the
subsystem Preliminary Design shall be marked with revision bars
to reflect the changes.

b. Updated product submittals for all, materials and components for
which product submittals were not previously submitted and
Engineer approved.

c. Complete Drawing index

d. Complete cable identification and equipment labels

e. Complete wiring diagrams for all equipment to be installed,
modified, upgraded, or interfaced

f. Top level mechanical drawings, if applicable

g. Grounding and protection details

h. Power panel schedule and distribution

D. Installation Work Plans and Detailed Documentation

1. Submit complete installation Work Plan and detailed documentation and
drawings no later than 60 days prior to the scheduled installation date
for each location and each subsystem.

2. Obtain Engineer’s approval of the Final Design submittal prior to
submitting installation detailed documentation applicable to a subsystem.

3. Organize the Installation Work Plan package to include the following
headings and information:

a. Scope and description of Work

b. Prerequisites

c. Tools

d. Installation personnel and their roles

e. Safety rules, regulations, procedures, and requirements

f. Permits, licenses, training including confined space, and
certifications

g. Planned access dates and times for each location, the Engineer’s
resources required for each location, and Operational Impact

h. Daily Preparation Procedures and Clean-up
i. Storage, staging facilities, security, and the overall job-site security

j. Installation procedures shall include each subsystem hardware and software components including any software and configuration settings and changes.

k. Installation drawings:
   i. Corresponding subsystem design review drawings with updates and details. Include detailed physical layout drawings with material list keyed to the layouts.
   
   ii. Cable and conduit schedules that show exactly where each cable is to be installed. Include and identify raceways, cable trays, conduit, junction boxes, pull boxes, manholes, hand-holes, and floor boxes. The cable and conduit schedules shall be accompanied with the corresponding voltage drop, cable gauge and conduit fill calculations, which shall be approved by the Engineer.
   
   iii. Cable and wiring connectors and terminal assignments.
   
   iv. Wiring diagrams to include terminal blocks, power panel details, Local Distribution Frames (LDF), Main Distribution Frame (MDF), and any additional wiring required for a complete design.
   
   v. Names and labels for all equipment including every wire, cable, connector, terminal and rack.
   
   vi. Electrical power diagrams and panel and power strip schedules.
   
   vii. Mounting, securing, seismic protection and installation details for all equipment and materials.
   
   viii. For racks in which equipment will be installed, rack-face elevations with all intra-rack and inter-rack wiring and cabling to be installed.
   
   ix. Power connections, panel schedules and grounding/protection connections.
   
   x. Location of all safety and hazard warning signs and labels.
   
   xi. Site Survey information.

E. Product Samples as required in individual subsystem Sections or where requested by Engineer.
F. Testing and Inspection

1. Submit Test Program no later than 60 days after Engineer’s Final Design approval, outlining Contractor’s overall testing strategy and schedule.

   a. The program shall include a list of all tests to be performed for all subsystems and integral equipment and materials to meet the requirements of these Specifications.

   b. The program shall include individual subsystem test plans.

   c. At a minimum, the test program shall cover the following testing activities:

      i. Factory Testing
      ii. Inspection
      iii. Field Equipment and Subsystem Testing
      iv. End-to-End Acceptance Test
      v. System Integration Test

   d. The test program shall include a list all the required tests per subsystem, to be performed in order to meet the requirements of these Specifications. This list shall be organized to include:

      i. Type of test
      ii. Tools and Test Equipment
      iii. Prerequisites
      iv. Pass and fail criteria
      v. Personnel and laboratory requirements
      vi. Required Cutover and Phasing: The cutover sequences shall be accompanied with the corresponding fallback procedures (should something go wrong).
      vii. Expected Impacts (Outages, Operational, Environmental, and Traffic, Revenue) and recovery Plan when required.
      viii. Engineer’s resources
      ix. Scheduled date and expected duration
      x. Additional Comments and notes

2. Submit test and inspection procedures no later than 60 days prior to the scheduled activity. All the required test and inspection procedure
submittals shall be detailed and organized to be consistent and include, but not be limited to the following heading and information:

a. Scope and Purpose: Clearly state the scope, case, and conditions the procedure tests.

b. Prerequisites: Describe test environment and the prerequisites, including access, availability, and equipment configuration for each group of functions.

c. References

d. Tools: List test equipment and tools, with calibration data for each item.

e. Personnel: List test participants and their roles.

f. Procedure: Contain enumerated step-by-step procedures. This shall include regression test and Pass and Fail Criteria.

g. Drawings: Include detailed drawings depicting test setup. This shall include list of equipment, parts and material used and tested.

h. A Test Data Form that includes space to record the tools with calibration date, environmental condition during the test, i.e., rainy, cloudy, and temperature, test measurement, pass and fail criteria and space to record the pass and fail outcome and the signature of the test engineer and a test witness.

3. The Test Exception Form shall be used to record the identifier of the defect report and problem report generated as a result of faults or problems detected during the test. All the troubleshooting techniques and corrective actions shall be documented on this sheet. All found defects and problems, occurred as a result of the Contractor's deficient design or implementation, shall be rectified and retested to the satisfaction of the Owner representative.

G. Test and Inspection Records and Reports

1. Submit all test and inspection records and reports within one week of completion of the corresponding test.

2. Test and inspection records shall be reviewed, signed and sealed to certify adherence to design requirements and standards.

3. Organize test and inspection report submittal to include the following headings and information:

a. Purpose/Introduction: Defines the submittal scope.
b. Test/Inspection Results Summary: Include measurements, results, problem areas, workarounds, troubleshooting, and exceptions.

c. Open Items: Identify any open items requiring resolution. Include the corrective action to resolve the open items.

d. Conclusion: This section shall document the Contractor’s review and how the test and inspection meets the system design and performance requirements outlined in the Specifications.

e. Completed Test and Inspection Records: A completed, signed, and dated test/inspection procedure sheets, as well as a defect/problem report for each fault/problem found during the testing.

H. As-built Documentation: In addition to the requirements of Section 01720, Contract Record Documents, submit the following documentation. Submit as-built versions of the following documentation sealed, as a minimum by a Registered Communications Distribution Designer (RCDD). Documentation with engineering design governed by codes and regulations shall be sealed and signed in blue ink by a professional engineer, currently registered in the State of California, for the discipline involved. Submit as outlined herein for the communications system:

1. Equipment inventory, with serial numbers including delivered, installed and spares.

2. Drawings as a minimum shall include those submitted under Final Design, installation and test procedure documents. The As Built drawings shall be numbered and grouped in accordance with Caltrain AutoCAD standards.

3. Final customized software data and source codes.

4. Final alarm, hardware, network and software configurations including required configurations of any operating systems to allow the system to properly function.

5. Final equipment configuration, provisioning, programming and settings.

6. Technical Specification to reflect the final system design implemented in the field.

PART 2 – PRODUCTS

Not Used. See individual Specification Sections under Division 17.
PART 3 - EXECUTION

3.01 INSTALLATION AND GENERAL DESIGN REQUIREMENTS

A. Refer to the Contract Drawings for information regarding Caltrain facilities and space in Caltrain facilities.

B. Environmental condition to which equipment shall be designed is defined in these Specifications.

C. Comply with IEEE 200.

D. Operation and Maintenance

1. Operating and maintenance safety shall be the highest consideration in equipment and subsystem design, construction, and installation.

2. Human Factors for operations and maintenance of equipment configuration and positioning shall:
   b. User interface equipment and characteristics such as display devices, preferred viewing angles, lettering, control devices and their tactile characteristics, indicators, use of colors, and use of audible indicators shall be consistent with MIL-STD-1472.

3. Where applicable, equipment and design shall comply with ADA requirements.

E. Continued Operation of Rail System

1. The Caltrain Rail System conducts Revenue Operations seven days a week. The existing Communications systems and the CCF (Central Control Facility) are in use 24 hours, seven days a week.

2. Installation, replacement, testing or modification of equipment or software during implementation of any new Communications System shall not disrupt continued operation of the Rail System, including operation of the CCF and Fare Collection system.

3. During revenue or non-revenue hours, any disruption to the existing Communications systems and CCF shall be minimized. To the extent possible, no more than a single node shall be unavailable through the existing Communications systems and CCF at any point in time with prior to the Engineer’s approval.

4. Coordinate with and obtain necessary approvals from authorities having jurisdiction for shutdowns, temporary diversions, utility relocations, temporary sidewalk closures, and pedestrian detours.

5. Refer to Sections 01011, Work Planning, and 01040, Work Hours and Track Access. Track access time is limited. Coordinate and comply with
requirements specified in Division 1, General Requirements, regarding track access and any work that could potentially interfere with the operating systems.

6. Follow Caltrain’s rules for access to and working in any rail operating territory.

F. Design Review Meetings

1. Preliminary Design Review
   a. Conduct a formal meeting for review of the Preliminary Design Submittal with the Engineer.
   b. The review shall be conducted no less than 21 days but no more than 45 days following an Engineer “approved” or “approved as noted” status of all the Preliminary Design submittals.
   c. Submit meeting minutes to the Engineer for concurrence no later than seven days after the Preliminary Design meeting.

2. Final Design Review
   a. Conduct a formal Final Design Submittal review meeting with the Engineer after the approval of all Preliminary Design submittals.
   b. The review meeting shall be conducted no less than 21 days but no more than 45 days following an Engineer “approved” or “approved as noted” status of the Final Design.
   c. Submit meeting minutes to the Engineer for concurrence no later than seven days after the Final Design meeting.

G. First Article Inspections

1. Perform First Article Inspection (FAI) for each subsystem and component that is custom built, custom assembled, or generally not accepted as a commercial off-the-shelf item or assembly. Examples of items for which an FAI should be performed include Communication Facilities and pre-wired Communications Cabinets.

2. The Engineer will determine the format in which the Contractor shall certify FAI performance based on the custom equipment or facility purchased. Examples include:
   a. Operational checklists of electrical system to include service outlets, lights, housekeeping alarms, and fire suppression.
   b. Operational checklists to show the functionality of custom made equipment which may include standby power systems, automatic signal switching, and alarm reporting.
   c. Cable run lists and equipment inventory records.
d. Cable (copper or fiber) test results.

3. The purpose of each FAI shall be to determine the following:

   a. Based on inspection, measurement, and basic operation, whether the layout and mechanical aspects of the unit under inspection, e.g., Communications Facility, are consistent with Engineer approved drawings, requirements of these Specifications, and other design documentation. If not, the subject unit shall be re-assembled and the FAI repeated. Where maintainability, e.g., accessibility, safety, status indicators, power indicators and control, and exposure to power connector, are present in the unit, assessment of those maintainability aspects shall be included in the FAI.

   b. Whether an acceptable level of workmanship that is consistent with approved workmanship standards and practices, is present in the initial copy of the unit under inspection. Where wiring, wiring connections, cabling, cable management, labels, tags or grounding connections are present in the unit under inspection, the workmanship standards, practices and procedures associated with the respective element shall be included as part of the FAI.

   c. Whether an acceptable level of operating and maintenance safety is provided in the initial product submittal. If not, the unit shall be re-designed and re-assembled.

4. For each subsystem and component, the FAI shall be conducted at the earliest possible time in the manufacturing stage.

5. Notify the Engineer at least 21 days prior to each FAI.

6. The Engineer may request an FAI on any subsystem or component. For those subsystems or components where the Engineer requires a FAI:

   a. Obtain the Engineer’s approval of the level of workmanship deemed to be acceptable.

   b. The following, applicable to the subject subsystem or component, shall be available at the time of the FAI:

      i. Engineer approved drawings and other design documentation

      ii. Subsystem or Component Parts List

      iii. Manufacturing and Quality Assurance Inspection Records

      iv. Test Plan and Procedures

      v. Tools and staff to make measurements
VI. Tools and staff to remove covers and perform limited disassembly

3.02 TESTING AND INSPECTION

A. This includes basic testing requirements. Where requirements for these activities are present elsewhere, the requirements specified in this Section shall be augmented by those additional requirements.

B. General

1. The Contractor shall:
   
a. Be responsible for successfully completing all tests required by these Specifications.

b. Provide all test instruments and any other materials, equipment and personnel needed to perform the tests.

c. Provide qualified personnel throughout all the required troubleshooting activities that may involve Communications System equipment.

d. Be fully responsible for the replacement of all equipment damaged as a result of the tests, and shall bear all associated costs.

e. Maintain comprehensive records of all tests.

f. Notify the Engineer in writing, no less than 21 days prior to each test activity including factory testing.

g. Provide test plans, procedures, records and reports for Engineer’s approval.

2. Engineer’s testing shall not be considered as a replacement for any Contractor required testing or manufacturer producing materials for the Contract required testing. The Engineer reserves the right to:

a. Inspect test records at any time.

b. Require the Contractor to perform additional testing, beyond that specified herein, of any equipment or material at any time to determine conformance with these Specifications.

c. Observe the on-site testing at any time at the Engineers discretion and without prior notification of the Contractor.

C. Factory Testing

1. Factory testing shall be conducted for:

   a. All equipment provided for installed.
b. All components installed, integrated, and operated as a subsystem (to be tested as a subsystem).

2. Subsystem factory testing shall occur only after Final Design submittal package approval for that subsystem.

3. Factory testing for a subsystem shall be successfully completed prior to shipping any equipment for that subsystem.

4. If the equipment for a location is assembled at the factory, factory conduct testing for that equipment after all the racks and other subassemblies are integrated and rack interconnections are in place.

5. In order to show proper operation of all aspects, behavior, and characteristics, minimum requirements for equipment testing include the following:

   a. Manufacturer’s Recommended Testing
   b. Environmental Testing for Custom Equipment
   c. Power-up Testing
   d. Equipment burn-in of 72 hours, with concurrent operation of the equipment, for the full burn-in period
   e. After burn-in, comprehensive functional testing, including testing of all controls and indicators
   f. After burn-in, comprehensive diagnostic testing
   g. After burn-in, comprehensive performance testing
   h. After burn-in, comprehensive external interface testing, including verification of the following:
      i. Electrical Interface
      ii. Functional Interface
      iii. Mechanical Interface

6. Minimum requirements for subsystem testing include the following:

   a. Comprehensive Functional Testing
   b. Comprehensive Performance Testing
   c. Comprehensive External Interface Testing, including verification of the following:
      i. Electrical Interface
ii. Functional Interface

iii. Mechanical Interface

iv. Rack-to-rack Interconnects

D. Installation Inspection and Test

1. Pre-installation inspection shall include inspection for the following:
   a. Missing components and parts
   b. Correct serial numbers
   c. Damage to equipment

2. Inspect installed equipment, as a minimum, for the following:
   a. Conformance to standards, methods, and quality
   b. Correct location, positioning, mounting, and orientation
   c. Damage to equipment
   d. Correct and secure external connections
   e. Correct and secure routing of cable and wires
   f. Correct and secure internal connections
   g. Proper Grounding and Protection
   h. Verification of all configuration data and setting
   i. Correct labeling

E. Field Equipment and Subsystem Testing

1. Perform the following equipment field tests for all installed equipment. Additional field tests for each subsystem, listed in the subsequent paragraphs, shall not be construed to limit or otherwise relieve the Contractor of the responsibility for performing comprehensive field testing of the following:
   a. Basic equipment operation
   b. Functional and performance testing
   c. All external interfaces such as mechanical, electrical, and functional
   d. Operation in the presence of equipment and software failures
   e. Operation in the presence of power failure and restart
2. Subsystem testing shall include the following:
   a. Tests for proper local operation
   b. Tests to confirm the installed equipment or subsystem meets performance requirements
   c. Validation of all data used to configure or operate the subsystem

F. End-to-End Acceptance Testing
   1. Refer to each Specification Section within Division 17, Station Communications.

G. Engineer’s Systems Integration Testing
   1. Conduct System Integration Testing (SIT) in accordance with Engineer’s requirements.
   2. Upon activation, interface, and integration of all required individual subsystems required for each line section cutover, provide SIT including technical support. Technical support shall include providing engineer, technician, and installation staff as well as tools, appliances, fixtures, expendable materials, supplies, and test equipment as needed to perform the SIT procedures or to develop and implement required corrective actions on the Contractor’s elements.
   3. This testing shall involve the interaction of the Communications System operating with one or more other sub-systems and shall be required through System Final Acceptance.
   4. SIT shall include testing of all communications subsystems added to, modified, or integrated as a result of work performed under this Contract and integrated or interfaced to existing systems and subsystems. Subsystem integration testing shall include:
      a. Rail Operations Control System (ROCS) and Passenger Information System indications and controls between intended field and control locations
      b. Station node integration
      c. Proper local and remote operation of Station PA and VMS messaging
      d. Proper operation of all voice circuits
      e. Proper transport and operation of TVM data and indications
H. Site Burn-In Testing

1. Where applicable, certain subsystems shall undergo a Site Burn-In Testing where the tested subsystem's equipment and software shall maintain normal functioning in a fully operational mode during a predetermined approved period of time (i.e. 15-day, 31-day, etc.). The goal is to ensure the subsystem’s performance in accordance with the Contract requirements while avoiding pre-defined number of occurrences of major and minor subsystem malfunctions (caused by the issues in the Contractor design and/or implementation). Contractor shall identify such major and minor malfunctions in the corresponding subsystem Test Plan and Procedures, which shall be approved by the Engineer.

2. If during the burn-in period of time, the subsystem exceeds the approved number/types of such malfunctions, the burn-in testing shall be stopped and considered failed. The Contractor shall review the subsystem's performance, submit for the Engineer’s approval the list of found issues with their explanation and proposed methods for rectifying the found issues. Upon correcting all such issues and as per approval by the Engineer, the burn-In testing shall restart again.

I. Inspections and Tests for Final Acceptance

1. Perform Final Acceptance inspections and tests for each portion of the Communications System following successful completion of System Integration Testing (SIT) for that portion. At this stage all the defects and other open items relevant to the system and identified up to that time, shall have been closed and system shall be ready for final inspection and acceptance test.

2. Inspection and tests as outlined in these Specifications shall demonstrate to the Engineer that, the System is operating in accordance with the requirements of these Specifications.

3. Perform “Complete Testing” for all equipment that exhibited faults during the SIT. “Complete Testing” shall be testing that is equivalent to the field and functional testing performed on the equipment when first installed are required by these Specifications and Engineer approved test procedures including submission of test results and test reports.

4. Perform “Complete Testing” for all equipment that was replaced under warranty. For all subsystems and equipment that have been changed after initial testing after installation, perform complete testing of such subsystem and equipment.

5. Verify the accuracy of the as-built documentation for each equipment location.

END OF SECTION
SECTION 17050
BASIC COMMUNICATIONS EQUIPMENT, MATERIALS, AND METHODS

PART 1 – GENERAL

1.01 DESCRIPTION
A. Section describes the detailed technical requirements for the products and miscellaneous components furnished, installed, and tested to complement the Station Communications subsystems.

1.02 GENERAL
A. The provisions of this Section apply to all Division 17, Station Communications, except as otherwise specified.

1.03 REFERENCE STANDARDS
A. American National Standards Institute (ANSI):

B. ASTM International (ASTM):
   1. A123 Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products
   2. A153 Specification for Zinc Coating (Hot-Dipped) on Iron and Steel Hardware
   3. B3 Standard Specification for Soft or Annealed Copper Wire
   4. D2447 Standard Specification for Polyethylene (PE) Plastic Pipe, Schedule 40 and 80, based on outside diameter
   5. E84 Surface Burning Characteristics of Building Materials
   7. F593 Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

C. Consumer Electronics Association (CEA):
   1. 310 Cabinets, Racks, Panels, and Associated Equipment.

D. California Building Code (CBC)

E. California Electric Code (CEC)

F. Electronic Industries Alliance (TIA/EIA)
1. 568-B.1-2 Commercial – Building Telecommunication Cabling Standard

2. 606 Administration Standard for the Commercial Telecommunications Infrastructure


G. International Building Code (IBC)

H. National Electrical Contractors Association (NECA):
   1. 1 Standard Practices for Good Workmanship in Electrical Construction

I. National Fire Protection Association (NFPA):
   1. 70 National Electrical Code (NEC)
   2. 130 Fixed Guideway Transit and Passenger Rail Systems
   3. 255 Standard Method of Test of Surface Burning Characteristics of Building Materials
   4. 703 Standard for Fire Retardant Impregnated Wood and Fire Retardant Coatings for Buildings

J. 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. LI1 Industrial Laminating Thermosetting Products
   7. VE1 Metallic Cable Tray Systems
   8. WC 7 Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
   9. WD 1 General Requirements for Wiring Devices


L. Underwriters Laboratories (UL):

1. 5 Surface Metal Raceways and Fittings
2. 6 Rigid Metal Conduit – Steel
3. 50 Enclosures for Electrical Equipment – Nonenvironmental Considerations
4. 50E Enclosures for Electrical Equipment – Environmental Considerations
5. 94 Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
6. 497 Standard for Safety Protectors for Paired Conductor Communications Circuits
7. 508 Industrial Control Equipment
8. 514A Metallic Outlet Boxes
9. 514B Conduits, Tubing and Cable Fittings
10. 651 Schedule 40 and 80 Rigid PVC Conduit and Fittings
11. 969 Marking and Labeling Systems
12. 1059 Terminal Blocks

M. Uniform Building Code (UBC)

1.04 SUBMITTALS

A. Submit Installation Work Plan including the following items:

1. Equipment layout, plan and elevation views
2. Conduit installation from Communications Equipment Room (CER) and field Distribution Cabinets (DC)
3. Wiring diagrams from CER to DC including all tagging identifiers

B. Submit a complete bill of materials (BOM) and the corresponding data sheets for all equipment and accessories, which the Contractor intends to use for the project (as a part of the Preliminary and Final Design).

C. Product Samples: Submit and demonstrate product samples when requested by the Engineer or when required.
D. Calculations and Certifications:

1. Calculations as listed in the Preliminary Design and Final Design. Refer to Section 17000, Basic Communications Technical Requirements.

2. Copy of ISO certification for all proposed manufacturers.

E. Software, Schedules, and Lists:

1. Submit dedicated cable management software for Owner’s use.

2. Submit typed (printed) wiring interconnect schedules and schedule of conduits, wires and cables as specified to be produced by required dedicated cable-management software.

3. Submit complete typed or printed list of cable, wire, and conduit identification tags for approval.

F. Manufacturer Qualifications: Submit qualifications for any manufacturer differing from those specified herein and obtain Engineer’s approval. Acceptability of the manufacturer shall be based on the manufacturer’s experience, qualifications, and certifications (i.e. ISO-9001); equipment reliability; compliance with specified standards; and full compatibility with Caltrain’s existing systems.

G. As-Built Documentation: Submit complete As-Built documentation and drawings, as specified in Section 17000, Basic Communications Technical Requirements, for all Miscellaneous Components and Products.

1.05 QUALITY ASSURANCE

A. Applicable Standards and Code:

1. All equipment and methods shall comply with the applicable standards listed under Reference Standards.

B. Material and Workmanship Requirements:

1. All equipment provided under this Section shall be UL listed.

2. All products specified herein shall be subject to Engineer’s approval based on the Contractor’s ability to demonstrate adherence to the specified requirement and approval of the manufacturer’s quality process.

3. Use no discontinued product models, refurbished equipment, or products scheduled for end-of-life, end-of-sale, or end-of-service within one calendar year of the installation date.

4. All grounding shall be in accordance with NEC standards, and as specified for the Work except as modified herein. Ground each piece of equipment in accordance with the recommendations of the manufacturer.
PART 2 – PRODUCTS

2.01 CIRCUIT BREAKERS, FUSES, AND FUSE CLIPS

A. Capacity:
   1. Fuses and circuit breakers shall be suitable for protection of the equipment and cabling connected.

B. Fuse Type:
   1. Fuses shall be non-renewable time lag fusion type.
   2. Protective resistance shall be used in branch circuits.

C. Fuse Clips:
   1. Positive contact pressure shall be applied to the fuses to ensure electrical continuity.

2.02 TAGGING

A. Cables, Wires and Conduits:
   1. Install cable identification tags at both ends of each cable, including wires, where they terminate on terminals, punch-down blocks, and connectors. Communications cable identifiers shall comply with standard TIA/EIA-606. This includes all electrical power wires and cable for communication facilities and equipment.
   2. Tag cables at the entrance and the exit of each manhole, pull-box, hand-hole, junction box, splice-box, cable trough, or fiber-slack enclosure.
   3. Tag conduits at the entrance and the exit of each manhole, pull-box, hand-hole, junction box, splice-box, cable trough, or fiber-slack enclosure.
   4. Use water-resistant identification tags with lamination over its designation for all conduits, cables, and wires. Permanently typed lettering shall be used.
   5. Use sleeve type non-metal tags where cable diameter permits.
   6. Use flat plastic tags for smaller cables (and all conduits): Two holes in the tag shall be provided for attachment with a dielectric tie.
   7. Furnish, use, and then submit to the Engineer a dedicated cable-management software, including software license, to provide Class 4 administration of the communication cables per standard TIA/EIA-606. Software shall be able to properly operate on Windows 2000, or latest revision of, operating system and be able to produce the following types of schedules:
a. Typed wiring interconnect schedule for all external and internal wires and cables listing wire (cable) tag identification, To and From locations, To and From termination terminals, wire (cable) size and type, all conduit (raceway) tag identifications that wire (cable) is installed, all raceway size and type, and manhole (pull-boxes) that cable or wire is installed through.

b. Typed wiring interconnect schedule for each location and each facility for the entire project.

c. Typed schedule of conduits, wires, or cables to include quantity of each.

8. Cable, wire, and conduit identification tags: The tags shall follow the following sample format. Each cable, wire, and conduit shall have its own unique identification tag. If a wire is not terminated, then tag it "spare-1", "spare-2", "spare-3", and so forth.

a. Sample tag scheme for External Cable, HIL-CER-FDP / BAS-CER-FDP-FS12-01; with:
   i. HIL represents originating location “from” (Hillsdale)
   ii. CER represents originating facility type (Communications Equipment Room)
   iii. FDP represents originating termination cabinet/panel (Fiber Distribution Panel)
   iv. / represents “to”
   v. BAS represents ending location (Bayshore)
   vi. CER represents ending facility type (Communications Equipment Room)
   vii. FDP represents ending termination cabinet/panel
   viii. FS12 represents cable type (Fiber Single-mode 12 strand)
   ix. 01 represents cable number (01-99)

b. Sample tag Scheme for Station Distribution Cable: HIL-CER-FDP / DC1-FS02-01; with:
   i. HIL represents Location “from”
   ii. CER represents facility type
   iii. FDP represents originating cabinet/panel
   iv. / represents “to”
v. DC1 represents ending distribution cabinet, panel, or equipment
vi. FS02 represents cable type (Fiber Single-mode 2 strand)
vii. 01 represents cable number (01-99)

c. Sample tag Scheme for Internal Wires within the same CER or DC, FS01-01-FDP-SL4-14 / RTU-TB5-11; with:
i. FS01 represents cable type (Fiber Single-mode 1 strand patch cord)
ii. 01 represents cable number (01-99)
iii. FDP represents originating cabinet/panel
iv. SL4-14 represents originating demarcation panel/card slot and port number
v. / represents “to”
vi. RTU represents ending cabinet, panel, or equipment
vii. TB5-11 represents ending termination block and termination terminal, jack, or port number

d. Sample tag Scheme for External Conduits, HIL-CER / BAS-CER-PCO-01-3; with:
i. HIL represents originating location area (Hillsdale)
ii. CER represents originating facility type
iii. / represents “to”
iv. BAS represents ending location area (Bayshore)
v. CER represents ending facility type
vi. PCO represents Pathway, such as “conduit”
vii. 01 represents conduit one (01-99)
viii. 3 inch represents 3 inch diameter conduit

e. Sample tag Scheme for Internal Conduits, CER-FDP / PB01-PCO-01-0.75; with:
i. CER represents originating facility type “from”
ii. FDP represents originating cabinet/panel
iii. / represents “to”
iv. PB01 represents ending pull-box, cabinet or equipment
v. PCO represents Pathway, such as “conduit”
vi. 01 represents conduit one (01-99)
vii. 0.75 inch represents 0.75 inch diameter conduit

B. Equipment:
1. Label all terminal blocks, card cages, circuit cards, punch-down blocks, and jack fields. Communications equipment identifiers shall comply with TIA/EIA-606.
2. Use permanent lettering scheme.
3. Attach labels with a non-drying adhesive.
4. Show the correct communication equipment identifier on every respective equipment drawing and schematic.

2.03 PUNCHDOWN BLOCKS

A. Type:
1. Blocks shall be IDC-Type 50 pair punch-down blocks. Blocks shall be configured with two columns of 25 pairs of two termination clips. Clips shall accept No. 20 AWG - No. 26 AWG insulated wire, and No. 18 AWG - No. 19 AWG bare wire. Blocks used for data cable termination shall be rated at or higher than the rating of the cable being terminated.
2. Clips shall be pre-wired to an Amphenol type RJ21X connector socket or equal.
3. Blocks shall be equipped with a base, standoff bracket, cover, and bridging clips.

B. Base:
1. The base shall be impact resistant plastic.
2. Provide molded fanning strips on each side of the split blocks.
3. Apply permanent numbering to the fanning strips.
4. Provide a standoff of two inches from the mounting surface.
5. Provide a removable cover with circuit designations permanently applied.
6. Provide connector retention screws.
2.04 TWENTY-FIVE PAIR CONNECTORS

A. Type:

1. Connectors shall be Amphenol-type RJ21X, or equal, with a self-extinguishing thermoplastic housing.

2. A slide on cover shall protect the connector contacts.

3. Provide retention screws.

4. Connectors shall be non-reversible and shall be compatible in design and type (male/female) with the associated receptacles.

B. Connector Contacts:

1. Provide two (2) rows of 25 contacts.

2. Contacts shall be insulation displacement type, designed to accept No. 22 and No. 24 AWG wire.

2.05 PROTECTED ENTRANCE TERMINALS

A. Design:

1. Use protected entrance terminals at the input for all signal/communications circuits using metal cable and entering/exiting the facility (e.g. Communications Facilities and DC). Use connectorized protected entrance terminals in all applications unless specifically stated otherwise in this Section or on the Contract Drawings.

2. Protected entrance terminals shall have a field splice line side connection stub pre-wired to three element (five pin) protector sockets. Connect the equipment side of the protectors via RJ21 connectors.

3. Blocks shall be 110 Cat 5e/6 rated or Engineer approved equal.

4. Protected entrance terminals shall include an integral splice chamber.

5. Provide protected entrance terminals in 25, 50, and 100 pair sizes and fully populated with protector modules as per the application shown on the approved drawings.

B. Protector Sockets: Protector Sockets shall be UL standard five pin sockets, with two-position (normal and detent) design. In the detent position, the protector shall be retained, the line side shall be disconnected, and the equipment side shall be protected. When fully inserted, the line and equipment side having the tip and ring pair shall be protected.
2.06 MULTI-PAIR PROTECTED TERMINAL BLOCKS

A. Design:

1. Utilize multi-pair protected terminal blocks for applications requiring non-connectorized 25 pair or less terminal blocks, as specified on the Contract Drawings.

2. Types and pair counts for terminal blocks shall be as shown on the approved drawings.

3. Terminal blocks shall consist of pairs of brass binding posts imbedded in high impact plastic potted with a high dielectric polyurethane compound.

4. Pre-wire binding posts to two element protector sockets. Wire the ground of all protector sockets to a common ground terminal.

5. Equip binding posts with two brass nuts and washers. Size binding posts to accept up to two No. 14 AWG conductors.

2.07 PROTECTOR MODULES

A. Three Element (5-Pin) Protectors: Protectors shall be solid-state modules with fuses or heat coils specifically designed for lightning protection.

1. Modules shall plug into 5-pin protected entrance terminal sockets.

2. Each module shall protect both halves of a pair.

3. Protector modules shall be UL 497 listed for primary protection.

4. Modules shall have 2 ns to 5 ns response time.

5. Modules shall protect for voltages over 230 Vdc.

6. Modules shall protect for currents over 80 A.

B. Two Element Protectors: Protectors shall be solid-state modules with fuses or heat coils specifically designed for lightning protection.

1. Modules shall plug or screw into protected terminal blocks.

2. Protector modules shall be UL 497 listed for Primary protection.

3. Modules shall have 2 ns to 5 ns response time.

4. Modules shall protect for voltages over 230 Vdc.

5. Modules shall protect for currents over 80 A.
2.08 MAIN DISTRIBUTION FRAMES

A. Communications Facilities Main Distribution Frame (MDF): Each MDF shall consist of the following minimum equipment:

1. A wall mounted 4 feet by 8 feet, 3/4-inch marine grade sanded and smooth surface plywood backboard for mounting equipment.

2. A minimum of two 100-pair connectorized protected entrance terminals (PET) fully equipped with protector modules for each active and inactive or unused circuit, as described in entitled Protected Entrance Terminals and Multi-Pair Protected Terminal Blocks herein. PET block shall be contained within a separate enclosure mounted on the MDF backboard. Enclosure shall have a fully removable cover in order to provide access to protected terminal blocks. (Mount on plywood backboard)

3. A minimum of eight 110 Type CAT 5e/6 50-pair connectorized punch-down blocks (as described in Articles entitled Punchdown Blocks herein) utilizing 25 pair connectors per Article entitled Twenty-Five Pair Connectors as cross-connects. (Mount on plywood backboard)

4. Provide binding post type terminal blocks as described in Article entitled Multi-Pair Protected Terminal Blocks herein and as shown on Contract Drawings. (Mount on plywood backboard)

B. Outdoor Distribution Cabinet (DC) Local Distribution Frame (LDF):

1. Each Outdoor DC or similar application shall consist of the following minimum equipment mounted to the Lexan panel mounted on the interior side panel of the DC:
   a. One duplex 120Vdc UPS receptacle and back-box. Receptacles will be NEMA L5-30R (twist lock).
   b. One duplex 120Vdc general purpose receptacle and back-box.
   c. Multi-pair protected terminal blocks designed for a minimum of 24-pairs of PA speaker and microphone connections. Such protection blocks shall be specifically designed for PA applications.
   d. Protection blocks for outdoor Category 5e/6 for Category 6 rated data wiring entering the facility or the cabinet.
   e. Protection blocks for any other outside plant cabling containing conductive (metal) elements. Such protection blocks shall be designed specifically for use with the intended application.
2.09 CABLE TRAYS

A. Cable trays shall be of open ladder type, aluminum, or other suitable material commercially available and providing support spacing and strength of material characteristics equal to or greater than the aluminum.

B. The aluminum ladder type cable tray shall meet the following requirements:
   1. Ladder rung spacing shall be approximately 6 inches.
   2. Side stringer section shall be a minimum of 0.094 inches.
   3. Top and bottom flange section shall each be a minimum of 2 inches.
   4. Flange width shall be approximately 0.75 inches.
   5. Height of rail shall be approximately 3.375 inches.
   6. Rung thickness shall be a minimum of 0.062 inches.
   7. Rung bottom width shall be approximately 2.20 inches.
   8. Rung top width shall be approximately 0.75 inches.
   9. Plastic tray insert barrier to separate power and signal cables.

C. Each cable tray shall be designed and fabricated with sufficient capacity to provide 50 percent of the cross-sectional area as free air space after the full number of cables and wires are installed. Sufficient overhead space must be available after installation to permit wires and cables to be inspected.

D. Where practical, the tray shall be constructed in straight sections joined with Engineer approved couplers. Electrical continuity of the tray shall be maintained across sections by bonding straps.

E. Using the manufacturer’s standard, the tray shall be laid out using a minimum number of sections, but providing maximum continuous runs without gaps.

F. All fittings, supports, and accessories shall be provided in accordance with the manufacturer’s recommendations.

G. Insofar as practical, cable trays shall be supported by cantilever type brackets in order that the cables can be laid into the tray without pulling.

H. Where the width of the cable tray or the loading of cables is such that cantilever supports are impractical, other Engineer approved suspension methods may be used, but such application must be kept to a minimum.

I. At least three supports shall be provided for each length of tray. Supports shall be evenly spaced insofar as possible; in no case shall the spacing between adjacent supports exceed five (5) feet.
J. To prevent damage to cables, no metal edges of any description shall protrude and no sharp corners shall exist in the completed layout.

K. Fiberglass support arms, where required to insulate the cable tray from the equipment racks, shall be flame retardant, reinforced polyester laminate Class "B" 130 degrees Celsius electrical sheet, meeting NEMA GPO-2 requirements specified in NEMA L11.

2.10 OUTDOOR EQUIPMENT CABINETS

A. Outdoor equipment cabinets shall be floor mounted encasing an 19 inch EIA aluminum equipment mounting rack. Cabinets shall have an overall height of 48 inches, unless otherwise indicated on the Contract Drawings. The cabinets shall have CEA-310 standard 1 3/4 inches spaced single side drilled, tapped mounting holes.

B. The cabinet base shall have a minimum depth of 30 inches. Cabinets shall have continuously welded seams and gasket front and rear doors.

C. Obtain the approval of the Engineer to finish the outside of each cabinet. All cabinets shall be painted identically.

D. Cabinets shall be equipped with screw clamp connection for grounding.

E. Cabinets shall be grounded to the Chassis Grounding Buss-bar (CGB). Each cabinet rack shall have separate 'signal/communications' and 'power' grounding bars, which are connected to the Chassis Grounding Buss-bar (CGB) independently from each other and from other racks (where applicable).

F. Cabinet shelves (both fixed and slide-out type) shall be provided as shown in the Contract Drawings.

G. Cabinets shall be equipped with ac power strip, ground bus-bars, horizontal and vertical cable management, and other non-electronic type components as shown on the Contract Drawings.

H. Cabinets shall be equipped with locking front and rear steel doors.

I. Cabinets shall be equipped with louvered side panels.

J. Cabinet design, furnish, and installation shall comply with Section 17160, Outdoor Communications Cabinets.

2.11 INDOOR COMMUNICATIONS CABINETS

A. Design:

1. Where communication equipment cannot be housed in open equipment racks within controlled spaces dedicated for communications only, locked cabinets shall be used and designed for EMI shielding with the following features:

a. Continuously Welded Seams
b. Gasket Front and Rear doors

c. Screened Ventilation Openings

d. Tested per Mil Std. 285

2. Cabinet construction and materials shall be as follows:

a. 14 gauge or heavier steel frame.

b. 16 gauge or heavier panels.

c. 16 gauge or heavier struts.

d. 16 gauge mounting rails with CEA-310 rack mount standard spaced holes for equipment mounting widths of 19 inches and 23 inches.

e. Both front and rear doors shall be removable.

f. Locking front and rear removable doors shall be provided. All keys shall be alike and master keys shall be provided to the Engineer.

g. Communications House cabinets shall be installed on insulating sills as shown on Contract Drawings.

h. Cabinet shelves (both fixed and slide-out type) shall be provided as shown in the Contract Drawings.

i. Cabinets shall be equipped with AC power strip, power and communications ground bus-bars, horizontal and vertical cable management, and other non-electronic type components as shown on the Contract Drawings.

j. Cabinets shall be equipped with louvered top and side panels.

3. Finish:

a. Obtain the approval of the Engineer to finish the outside of each cabinet. All cabinets shall be painted identically.

b. Finish inside of each cabinet in flat white enamel.

c. Racks or cabinets shall be grounded to the Main Grounding Buss-bar (MGB) as shown in the Contract Drawings.

2.12 MULTI-PAIR DISCONNECT MODULE TERMINAL BLOCKS

A. Design: Multi-pair disconnect module terminal blocks shall be 110 Type CAT 6 Rated or Engineer approved equal. Terminal blocks shall provide normally closed two-piece (line side and equipment side) insulation displacement contacts in 8 to
50 pair modules, as per the application shown on the Contract Drawings. Disconnection of the line side from the equipment side shall be by insertion of a disconnect plug.

B. Performance:
1. Contacts shall accept No. 20 AWG through No. 26 AWG insulated conductors.
2. Contact resistance shall be less than 1X10-3 ohms.
3. Insulation resistance shall be greater than 50X10(12) ohms.
4. Wire retention force shall be greater than or equal to 75 percent of wire breaking force.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: All parts of the specifications pertaining to miscellaneous components and products shall be installed as specified in this specification and in accordance with the Contract Drawings.

B. Twenty-Five Pair Connectors:
1. Cable Attachment Tool: Twenty-five pair connectors that are attached to cables in the field shall be made-tip utilizing an Engineer approved connector attachment.
2. Testing: Test twenty-five pair connectors that are attached in the field, utilizing an Engineer approved tester that detects opens, shorts and crosses. Also, verify color code.

C. Terminal Blocks:
1. Make connections to terminal blocks in accordance with the Engineer approved connection details. Utilize twisted pair jumper wire for cross-connections.
2. Neatly bundle all wiring on terminal blocks and restrain to prevent tracing wires by pulling.
3. Utilize tags and labels to identify the terminal block designation and the pair number terminated on each terminal.
4. For protected terminal blocks, ground protected terminal blocks with No. 6 AWG minimum ground wire to the cabinet communications ground.
5. Test all protector modules prior to installation on terminal blocks.
D. Main Distribution Frames:

1. Backboard Mounting in Communications Facilities.
   a. Secure plywood backboard to the wall in such a manner that it will adequately support the weight of all equipment and cables that are attached to it. Cable termination and management devices shall be provided and subject to the Engineer’s approval.
   b. Prime and apply fire retardant paint to the backboard to all exposed sides prior to installation of any equipment.
   c. Floor conduit stub-ups shall be extended to 2 feet above finished floor as shown on the Contract Drawing.

2. MDF and miscellaneous equipment mounting in Distribution Cabinets (DC) shall be as shown on Contract Drawings.

3. Wiring:
   a. Wire each MDF in accordance with an approved cross-connect and wire termination plan.
   b. Utilize tags and labels to identify the cross-connect module designation and the pair number terminated on each quick-clip. All tag and label designations shall be transferred to the as-built drawings. Method of tagging and labeling shall be in accordance with Article entitled Tagging herein.
   c. Neatly bundle cables and cross-connect wiring and restrained using Velcro ties.
   d. Individually ground each distribution frame, equipment rack or cabinet, protected terminal block, or cable tray section, to the Communications Equipment Room (CER) Main Grounding Bus-bar (MGB) with No. 6 AWG ground wire and lugs as shown on the Contract Drawings.

E. Cable Tray:

1. Attachment: Each cable tray section shall be attached to the Communications Facility ceiling utilizing expansion fasteners required for the ceiling material. Fasteners shall be rated for a pull-out load equal to at least 150 percent of the maximum rated load for each cable tray section.

2. Cable trays shall be attached horizontally to 19” racks to provide neat and secure mounting of equipment cables.

3. Grounding: Cable tray shall be grounded to the Communications Facility MGB utilizing No. 6 AWG minimum ground wire. Electrical continuity of the cable tray shall be maintained between sections utilizing No. 6 AWG
minimum ground wire and attachment hardware, as recommended by the manufacturer.

4. Installation of Cable:

a. Cables shall be laid into the tray, rather than pulled, wherever possible, so as to eliminate twisting. Cables shall be attached to the tray utilizing dielectric ties so as to maintain straight runs and adequate separation of cables. Cables carrying ac and dc power shall be separated from audio and data cables to the maximum extent possible.

b. Fiber optic distribution cables will be encased in 1 inch inner-duct and attached to the tray utilizing dielectric ties. Fiber and inner-duct shall be separated from copper cables. Inner-duct will run the full length of the cable tray to the Fiber Distribution Panel (FDP) opening.

c. Fiber Optic patch cables shall not be installed with bend diameters less than those specified by the vendor.

F. Internal Wiring and Cabling:

1. Internal wiring shall be installed in wiring harnesses or cable trays.

2. Wire and cable shall be secured within ducts or open wire ways to prevent chafing movement.

3. Strain relief shall be provided where needed.

4. Wire or cable splices will not be permitted.

5. All wires and cables shall be fully protected against any contact with any surface other than that designed specifically to support or protect them.

6. Wires and cables shall be laid in place with sufficient slack at the bends so that wires and cables will clear the inside bend surface of the wire way, thereby preventing the insulation from being crushed.

7. All wire and cable shall be free of kinks and insulation damage. Wire installation shall not be subject to accumulations of moisture or foreign matter.

8. Wire and cable dress shall allow for sufficient slack to provide for shock and vibration induced movements, movement of sliding racks, equipment shifting, alignment, cover removal, and component replacement.

9. All wire and cable bends shall conform to the manufacturer recommended wire/cable specific minimum bend radius. All wire and cabling harness and dress arrangements shall also account for this requirement.
10. Wiring and cabling dress in harness arrangements shall be tied with a high strength approved Velcro type wire-tie.

11. For rack wiring, utilize rack’s cable management hardware for routing and securing of the wires and cables.

12. All wires and cables shall be free from metal edges, bolt heads, and other interference points, and shall have electrical clearance from the covers, regardless of the insulation properties of covers or doors.

END OF SECTION
SECTION 17060
GROUNDING OF COMMUNICATIONS EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION
A. Section includes requirements for grounding and bonding for communications systems.

1.02 REFERENCE STANDARDS
A. American National Standards Institute (ANSI):
   1. J-STD-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

B. American Society for Testing and Materials (ASTM International):
   1. B187 Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar and Shapes
   2. B3 Specification for Soft or Annealed Copper Wire
   3. B8 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
   4. B8 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
   6. D5 Test Method for Penetration of Bituminous Materials
   7. D149 Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
   8. D257 Test Methods for DC Resistance or Conductance of Insulating Materials

C. Institute of Electrical & Electronics Engineers (IEEE):
   1. 80/81 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
   2. 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems
3.  1100  Recommended Practice for Power Grounding Sensitive Electronic Equipment

D.  Lightning Protection Institute (LPI):
   1.  175  Standard of Practice
   2.  176  Standard of Materials

E.  National Fire Protection Association (NFPA):
   1.  70  National Electrical Code (NEC)
   2.  130  Fixed Guideway Transit and Passenger Rail Systems
   3.  780  Standard for the Installation of Lighting Protection Systems

F.  National Electrical Safety Code (NESC)

G.  California Electric Code (CEC):
   1.  Title 24 California Electrical Code Part 3

D.  Underwriters Laboratories (UL):
   1.  467  Safety Grounding and Bonding Equipment

1.03  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 for the Grounding and Bonding of communications systems
   1.  Manufacturer’s catalog data for all proposed materials with installation recommendations. Product data sheets shall include, but not limited to, the following:
      a.  Ground conductors
      b.  Connectors, bushings, and fittings
      c.  Exothermic welding process, materials, and molds
      d.  Ground rods
      e.  Ground test stations and Bus Bars
      f.  Ground Well Boxes (where applicable)
      g.  Lightning/Surge protection and arrester equipment
2. Master Drawing Index
3. Drawings showing grounding arrangement for communications facility and cabinets, including locations of ground rods, cables and connectors.
4. Drawings showing details of ground connections, ground test stations, ground risers, terminations and access points, including details of connections of panels and their end connections to the Main Grounding Bus-bars (MGB); and typical grounding details showing electrical systems, equipment, metallic conduit/cable tray and non-current carrying conductive entity grounding and bonding connection.
5. Drawing showing mounting details of all ground bus-bars.
6. Grounding calculations to demonstrate the installation meets the Specification requirement of the 3 ohms.

C. Final Design Technical Requirements: Shall include the following information as part of the Final Design submittal package for the Grounding and Bonding of communications systems.
1. Updated Preliminary Design information. All drawings, calculations and design information shall reflect a final design.
2. Final installation details.

D. Installation Work Plans: Shall include the following installation documents for each site with scheduled installation activity in accordance with these Specifications.
1. Locations of ground rods, connectors, cables, and details of connections, terminations and access points.
2. Manufacturer’s installation recommendations.

E. Certifications: Certified test reports verifying that ground resistance of each ground grid when installed and each ground bus when connected to the ground grid does not exceed specified values.

F. Product Samples: Submit and demonstrate product samples when requested by the Engineer.

G. Test Plan and Procedures: Submit procedures and equipment for testing resistances and electrical continuity for each location.

H. Test Records: Submit test records including Test Records and Results for Engineer review no later than one week after the completion of each test.

I. As-Built Documentation: Refer to Section 17000, General Communications Technical Requirements, for requirements. Include complete As-Built documentation and drawings for the Grounding and Bonding of all communications systems completed.
1.04 QUALITY ASSURANCE

A. Design, fabrication, inspection, installation and testing shall comply with all applicable Standards and Codes as listed under Reference Standards.

B. Material and Workmanship Requirements:

1. All equipment and material provided under this Section shall be UL listed.

2. All grounding shall be in accordance with local standards, except as modified herein. Each piece of equipment shall be grounded in accordance with the recommendations of the manufacturer.

3. Use no discontinued product models, refurbished equipment, products at their end-of-life, end-of-sale, or end-of-service.

C. All products specified herein shall be subject to the Engineer approval based on whether Contractor demonstrates adherence to the specified requirement and Engineer approval of the manufacturer’s quality process.

PART 2 - PRODUCTS

2.01 GENERAL DESIGN REQUIREMENTS

A. Grounding/bonding systems shall provide for the following three primary functions:

1. Personnel safety

2. Equipment and building protection

3. Electrical noise reduction

B. Subsystem: Facilities Lightning Protection

1. A lightning/surge protection system shall be provided for all communications and wayside facilities including Communications Facilities, outdoor Public Address/Visual Message System (PA/VMS) equipment, Ticket Vending Machines (TVMs), Closed Circuit Televisions (CCTVs), Card Interface Devices (CIDs) or Clipper, Communications Equipment Rooms (CERs) and Distribution Cabinets (DCs). The lightning protection system shall be in accordance with the requirements of ANSI/NFPA 780, Lightning Protection Code. The lightning protection system shall consist of multiple facility/equipment air (lightning) terminals, lightning/surge arrestors, down conductors, equalizing conductors, and ground terminals. This hardware shall provided for the Communications Facility for the purposes of intercepting, diverting, and dissipating direct lightning strikes or adjacent power lines faults, electrical ground faults, short circuits, and transients.

2. The spacing and interconnection of the lightning protection system with the communications system grounds shall be in accordance with ANSI/NFPA 780. Communications grounds shall be bonded to the
lightning protection system grounding within 12 feet of the base of the building. Communications conductors shall not be routed closer than 6 feet from any lightning protection system conductors. The grounding and bonding design scheme shall include an assessment for Lightning Protection System and bonding requirements as part of the Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC) Control and Test Plan.

3. Lightning protection systems and installers shall be certified to LPI-175 and LPI-176 standards.

2.02 GROUND RODS

A. Ground rods shall be medium carbon steel core, copper-clad by the molten weld casting process, of the non-rusting type as manufactured by Copperweld Corporation, or approved equal. The rod shall be at least 1 inch in diameter by 10 feet long, UL listed. Where the design calculations show as required, rod installations of more than 10 feet length shall utilize sectional type ground rods joined by threaded copper alloy couplings.

B. Ground rod clamps shall be made of a cast bronze clamp body with non-ferrous setscrews as manufactured by Copperweld Corporation or an Engineer approved equal.

2.03 EXOTHERMIC WELDS

A. Welding material shall consist of copper exothermic mixture employing tin-metal in an amount to effectively constitute 4.5 percent to 5.5 percent of the resulting weld metal. The resulting weld metal shall be of high electrical conductivity and shall have a minimum tensile strength of 39,000 pounds per square inch (psi).

B. Coating Materials for Welded Connections: Use black, rubber based compound coating materials, which are soft, permanently pliable, moldable, and unbacked, not less than 1/8 inch thick, with properties as follows:

1. Solids: 100 percent
2. Density: 12.0 pounds per gallon minimum
3. Penetration: 90-130 ASTM D5
4. Water Absorption: 0.10 percent maximum ASTM D570
5. Dielectric Strength: 500 volts/mil ASTM D149
6. Volume Resistivity: 2,000 megohms-inches ASTM D257 5,000 megohms-cm ASTM D257
7. Service Temperature: - 10 degrees F to +160 degrees F
8. Chemical Resistance: Melting point, none; flammability, slow burning (ASTM C653); resists alcohol, water, aqueous hydrochloride and sodium
hydroxide; dissolved by carbon tetrachloride, naphtha gasoline, mineral, spirits, and benzene.

C. Highly cohesive and adheres strongly to metals and adhesive concrete and to itself.

D. Compression or mechanical type grounding connections are not equal to exothermic welded connections for applications in concealed, underground, wet or damp location, and are not permitted.

2.04 GROUND GRID CONDUCTORS

A. No. 2 AWG bare solid tinned copper conductor, or as shown on Contract Drawings.

2.05 GROUND ELECTRODE CONDUCTORS

A. Insulated stranded copper conductor, as shown on Contract Drawings, in accordance with these Specification, for single-conductor cable, 600 volts.

B. Size unless otherwise shown:

1. When connecting ground grid to Telecommunications Main Grounding Bus-bars (MGB) at Communications Facilities, insulated No. 2 AWG will be used. Use green color insulation for such conductors.

2. When connecting ground grid to Telecommunications Grounding Bus-bars at cabinets, insulated No. 6 AWG will be used. Use green color insulation for such conductors.

3. For other grounding electrode conductors: In accordance with NEC Table 250 94.

C. Equipment Grounding Conductors

1. Size in accordance with NEC article 250-95, unless otherwise shown on Contract Drawings.

2. Equipment grounding insulated conductor: No. 6 AWG single conductor stranded copper as specified in these Specifications. Use green color insulation for such conductors.

D. Static Dissipative Tile: Static Dissipative Tile (SDT) shall be used in Communications Facilities to prevent equipment damage due to static discharge. Ground SDT ground strips to the MGB in accordance with the manufacturer’s instructions using a minimum of No. 12 AWG copper wire.

2.06 TELECOMMUNICATIONS MAIN GROUNDING BUSBARS

A. Telecommunications Main Grounding Bus-bars (MGB), located in Communications Facilities shall be as follows:

1. ASTM B187, 98 percent conductivity copper.
2. Predrilled electro-tin plated copper bus-bar provided with standard NEMA bolt-hole sizing and spacing for the type of connectors to be used.

3. Sized in accordance with the immediate requirements of the application and with consideration for future growth (provide approximately 50 percent spare holes).

4. Minimum dimensions shall be ¼ inch thick x 4 inches wide and variable in length.

B. Communications Ground Buss-bar (CGB) located in communication cabinets shall be as follows:

1. ASTM B187, 98 percent conductivity copper.

2. Predrilled electro-tin plated copper bus-bar provided with standard NEMA bolt-hole sizing and spacing for the type of connectors to be used.

3. Sized in accordance with the immediate requirements of the application and with consideration for future growth (provide approximately 50 percent spare holes).

4. Minimum dimensions shall be ¼ inch thick x 2 inches wide and variable in length, or as shown on site specific drawings.

2.07 TERMINAL LUGS

A. Lugs shall be suitable for attaching a ground conductor to equipment or metallic surfaces, and shall be NEMA 2-hole, compression type chosen as follows:

1. For No. 4/0 AWG and smaller conductors, use copper compression terminal lugs.

2. For No. 250 MCM and larger, use long barrel, copper, double-compression terminal lugs.

2.08 GROUND CONNECTOR

A. Mechanical connectors shall be used for grounding connections above ground in dry locations only, and for attachments to equipment, boxes, or finished electrical devices

B. O-Z Gedney, Type KG or Engineer approved equal.

C. Two-piece, designed for connecting grounding conductor to bus bar.

D. Copper alloy body and silicon bronze bolt, nut and washer with interlocking clamp.

E. Exothermic weld: Size and type per manufacturer’s recommendations. See also subpart 2.03 above.
2.09 JUMPERS
A. Jumpers shall be insulated copper braided or leaf-type flexible jumper, size as required.

2.10 BUSBAR INSULATORS
A. Fibrous glass reinforced polyester insulator with 1/2 inch diameter by 2 inches length, threaded holes at both ends for MGB and CGB installation.

2.11 COAL TAR EPOXY
A. Polyamide cured coal tar epoxy, Dupont Coriar 823 CTE, Koppers Company No. 300M, PPG Industries 97-640 or 97-641 or Engineer approved equal, applied to a dry film thickness of 15 mils, per coat.
B. Coal tar epoxy coating products shall have the following minimum properties:
   1. Minimum volume resistivity of 1010 ohm-centimeters.
   2. Thickness as recommended by the manufacturer for the specified system but not less than 15 mils.
   3. Provide a chemical or mechanical bond to the metal. Pressure sensitive or nonbonding systems are not acceptable.
   4. Mechanical characteristics capable of withstanding reasonable abuse during handling and installation and earth stresses after installation for the design life of the system

2.12 EPOXY RESIN ENCAPSULATION
A. Two-component epoxy resin type with plastic snap mold, as manufactured by Duriron Company, 3-M Company or Engineer approved equal.

2.13 COMMUNICATIONS FACILITY ROOM HALO GROUND RING
A. The halo shall be No. 4 AWG bare stranded copper conductor. It shall encircle the perimeter of the interior walls of the Communications Facility at a uniform height of 3 inches to 12 inches from the ceiling. The halo shall be bonded to the MGB also using a No. 4 AWG bare stranded copper conductor and Engineer approved ground connector.

2.14 COMMUNICATIONS CIRCUIT PROTECTION
A. Related to copper cables that enter all Communications Facilities and Distribution Cabinets (DCs). All signal/communications copper cables shall terminate on Protected Terminal Blocks (PTB) (rack-mounted, wall-mounted or at the Main Distribution Frame (MDF) as per Contract Drawings), and shall conform to these specifications. Where applicable, cable sheath shall be neatly trained and bonded to the MGB (or CGB) using a No. 6 AWG insulated ground conductor.
PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for products specified in this Contract Specifications Section.

B. Note items that may infringe on the necessary clearances and other non-compliances. Promptly bring noted issues to the attention of the Engineer for direction and approval before proceeding

3.02 GENERAL GROUNDING AND BONDING REQUIREMENTS

A. Provide all grounding and bonding as specified. Where applicable, all building or outside enclosure grounded systems shall be interconnected with the lightning protection grounding system.

B. Grounding conductors shall be protected from physical and environmental damage. Wherever possible, grounding and bonding conductors routed in rooms shall be enclosed in a non-metallic raceway. Exposed conductors, which shall extend from a concrete surface, shall be located as close as possible to a corner. Where conductors are required to run exposed, as in the connection to the main ground bus, grounding conductors shall be supported by corrosion resistant metallic hardware at 4-foot intervals or less.

C. Completely remove all paint, dirt, or other surface coverings at grounding conductor connection points so that good metal-to-metal contact is made.

D. Service grounds and grounding or bonding of electrical service equipment shall be with continuous un-spliced grounding conductor.

E. If an existing facility or outdoor cabinet is being retrofitted, test and, if necessary, upgrade their grounding system to the level specified within these specifications.

3.03 INSTALLATION

A. Grounding Connections

1. Weld buried ground connections exothermically, in accordance with manufacturer’s recommendations. Clean and coat with coal tar epoxy applied with a 32 mils dry film thickness using multiple coats. Allow drying between coats and before backfilling. Encapsulate with epoxy resin all buried ground connections of grounding electrode conductors running to ground buses.

2. Use terminal lug to connect grounding conductor to equipment enclosure. Secure connector or terminal lug to the conductor so as to engage all strands equally by using tools and pressure recommended by the manufacturer. Make connections with clean, bare metal at points of contact.
3. Exothermically weld connections for ground rods in manholes and handholes, or as shown.

4. Splices or soldering in grounding conductors are not permitted.

5. Bolted connections shall not be buried or embedded.

B. Ground Grid

1. Install ground grid consisting of bare solid tinned copper conductors and ground rods buried in earth in the pattern and at the locations shown on site drawings. Ground rods will be minimum 10 foot length, 1 inch diameter. Install ground rods vertically if possible. Where vertical burial is not possible, rods may be at an angle or (as a last resort) buried horizontally 30 inches (minimum) below grade.

2. Bury top of ground rod 30 inches minimum below grade or as shown on Contract Drawings. If extensive rock formation is encountered, relocate ground rods to a new location as approved by the Engineer.

3. Provide 24-inches minimum horizontal separation between ground rods and concrete structures.

4. Interconnect ground rods using bare solid tinned copper conductors as shown on site specific drawings.

5. For Communications Facilities provide two pigtails of grounding electrode conductor of sufficient length above finished floor for connection to the MGB. The two pigtails shall be exothermically welded or bonded in an Engineer approved manner to the grounding grid at a single point.

C. Grounding Bars

1. Install the Telecommunications Main Ground Buss-bar (MGB) as shown on Contract Drawings.

2. Mount the MGB on insulators 2 feet above finished floor using cap screws and expandable threaded anchors, unless shown otherwise on Contract Drawings.

3. Install the distribution cabinet CGB in the bottom of the cabinet, on insulated spacers which electrically isolate them from the cabinet.

4. Provide insulator support at each end of grounding bus-bars and at intervals not exceeding three feet.

5. Bond the grounding electrode conductors to the grounding bus-bar using an Engineer approved ground connector in accordance with this Section.

6. Grounding of Separately Derived ac Power System
7. Bond the safety ground conductor (green wire) to the MGB using a minimum of No. 4 AWG insulated stranded copper wire, as shown on Contract Drawings. For additional guidance refer to the NEC.

D. Grounding for Personnel Safety

1. In Communications Facilities and cabinets, bond equipment enclosures and racks, ductwork, conduit, metal cable trays, the LDF ground bolt, PTB grounds, and the room halo ground ring to the local MGB or CGB using a minimum of No. 6 AWG insulated stranded copper conductor or as specified on Contract Drawings.

2. Wayside metal equipment including, but not limited to, cabinets, poles, pull-boxes, equipment enclosures, and junction boxes: bond and ground each item using No. 6 AWG (minimum) copper conductor to one or more ground rods to provide 3 ohms or less resistance to ground.

E. Electronic Equipment Signal Grounding

1. Electronic equipment shall have separate ‘Signal’ or ‘Telecommunications’ ground connections, which shall be implemented as a separate isolated ‘Signaling’ ground bar (as opposed to a ‘Power’ ground bar) in the equipment rack or enclosure. These connections shall be grounded to the ‘Signaling’ ground bar using a minimum of No. 10 AWG insulated stranded copper conductor and shall be separate from ground connections to the ‘Power’ ground bar. Each rack’s (or enclosure’s) ‘Signal’ and ‘Power’ ground bar shall have an individual connection of a minimum of No. 6 AWG insulated stranded copper conductor to the facility’s or cabinet’s corresponding ‘Signal’ and ‘Power’ TMGB (see below).

2. Where the Communications Equipment Room (CER) is shared with non-communications electronic equipment, a separate TMGB shall be provided. All individual equipment racks or enclosures shall be grounded to the TMGB using a minimum of No. 6 AWG insulated stranded copper conductor.

3. The TMGB shall be grounded to the same point on the ground grid (or to the structural steel) as the electrical service entrance to form a single-point building ground system.

F. Cable Shield Grounding: One end of all cable shields shall be grounded to the TMGB. Use the following guidelines to determine which end of the cable to ground:

1. When a cable goes between CER, ground the shield at the southern most facility.

2. When a cable goes between a CER, and any other facility (TPSS, Signal House, and Distribution Cabinet), ground the shield only at the Communications Facility.

3. Audio cable shield shall be grounded only at CER.
4. When a cable goes between the distribution cabinet and the station equipment, ground the shield at the station. If existing conditions make grounding of the entering cable shield challenging at the existing stations, as per approval by the Engineer the shield grounding can be executed at the distribution cabinet.

G. Fiber Optic Cable Jacket Grounding: Armored jackets (if used) on all fiber optic cables shall be grounded to the MGB using a minimum of No. 6 AWG insulated stranded copper conductor. Where possible, station communication design will use an all-dielectric fiber optic cable plant.

H. Copper Cables Lightning/Surge Suppression: Lightning/Surge Suppression Devices shall be installed at every electric, communication, or data copper cable entrance at the Communications Facility or Distribution Cabinet. The type of the protection device shall correspond to the application specifics of each protected copper cable (as per vendor recommendations) and shall ensure protection of not only ‘working’ conductors/pairs, but also the spares.

3.04 TESTING AND INSPECTION

A. Perform the following inspections and tests on Grounding and Bonding. Notify the Engineer in writing prior to each test and inspection so that the Engineer may be present as desired.

1. Factory Test and Inspection: Perform Factory inspection and testing of the ground terminations for each rack/enclosure ‘Signal’ and ‘Power’ ground bars’ terminations.

2. Field Test and Inspection. Perform the following Field Inspections and Tests:

   a. Inspect ground grid installation, installation depth, conductor sizes, connections to ground rods and foundation rebar prior to backfill, for conformance to Specification requirement.

   b. Inspect installation of all ground bus-bars for proper mounting.

   c. Test ground resistance of each ground grid after installation and each ground bus when connected to ground grid, using Engineer approved test procedure.

   d. Resistance to ground for Communications Facilities and distribution cabinets shall not to exceed three ohms.

   e. To meet resistance requirements, install additional ground rods. If resistance requirements can still not be met, install a sacrificial anode to be approved by the Engineer.

   f. Test metal conduit and raceways, equipment enclosures, metal cable troughs, fences, metal structures, and light poles for ground resistance not to exceed three ohms.
g. Test all GFCI receptacles and circuit breakers for proper ground connections and protection operation with methods and instruments prescribed by the manufacturer.

B. End-To-End acceptance Test: Not required.

C. System Integration Test: Not required.

END OF SECTION
SECTION 17100
COMMUNICATIONS FACILITIES

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes requirements for facilities to house equipment for the Station Communications.

1.02 REFERENCE STANDARDS

A. American National Standards Institute (ANSI):

1. TIA/EIA-568 Commercial – Building Telecommunication Cabling Standard

2. TIA/EIA-J-STD-607 Commercial Building Grounding and Bonding Requirements for Telecommunications

B. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):

1. ASHRAE Handbook of Fundamentals, Chapter 26

2. ASHRAE Publication SPCDX (Climate Data for Region X)

3. Gdl 16 Specifying Outside, Return, and Relief Dampers for Variable Air Volume Systems

4. Gld 19P Ventilation and Indoor Air Quality

C. ASTM International (ASTM):

1. A653 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

2. B3 Specification for Annealed Copper Wire

D. American Society of Civil Engineers (ASCE):

1. ASCE 7 Minimum Design Loads for Buildings and Other Structures

E. California Building Code (CBC)

F. California Electric Code (CEC)

G. Illuminating Engineering Society of North America (IES):

1. RP-7 Practice for Industrial Lighting

H. International Building Code (IBC)
I. Institute of Electrical and Electronics Engineers (IEEE):
   1. 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book)

J. International Organization of Standardization (ISO):
   1. 9001 Recommended Practices and Procedures, Quality Assurance (QA) and Quality Control (QC)

K. National Fire Protection Association (NFPA):
   1. 70 National Electrical Code (NEC)
   2. 72E Standard on Automatic Detectors
   3. 101 Life Safety Code

L. National Electrical Contractors Association (NECA):
   1. NECA 1 Standard Practices for Good Workmanship in Electrical Contracting

M. National Electrical Manufacturers Association (NEMA):
   1. AB 1 Molded Case Circuit Breakers and Molded Case Switches
   2. CC1 Power Connections
   3. PB1 Panelboards
   4. FB1 Fittings, Cast metal Boxes and Conduit Bodies for Conduit and Cable Assemblies
   5. VE1 Metallic Cable Tray Systems

N. Underwriters Laboratories, Inc. (UL):
   1. 50 Safety Enclosures for Electrical Equipment
   2. 67 Panelboards
   3. 467 Grounding and Bonding
   4. 497 Protectors for Paired Conductor Communication Circuits
   5. 969 Marking and Labeling Systems

O. Uniform Building Code (UBC)
1.03 DEFINITIONS

A. “Facilities” shall mean conditioned space required to house station communications equipment primarily at larger stations, where said equipment cannot be confined to an outdoor Communications Interface Cabinet (CIC), also sometimes referred to as Station Communications Cabinet (SCC). This space is commonly referred to as the Communications Equipment Room (CER). Communications Facilities are divided into two types. The facilities required to house the CER shall be a prefabricated shelter (“House”) (Type I) or a space within a new or existing building within or near the station (Type II).

B. Communications Facility, Type I: A stand-alone prefabricated structure, located near (within 500 feet) of the passenger station, that shall house all the required network communications equipment to service the station. Included in this facility shall be the communications carrier equipment (owned or leased) required to link the Central Headquarters in San Carlos, and the Central Control Facility (CCF) with the station, as well as the station subsystem distribution equipment.

C. Communications Facility, Type II: This facility shall be a room within a combined structure to be built or remodeled as an integral part of a station. This Communications Equipment Room (CER) shall contain all the required network and subsystems communications equipment to service the passenger station.

1.04 SYSTEM DESCRIPTION

A. Both Type I and Type II Facilities equipment and infrastructure shall include the following: Fiber Slack Enclosure (FSE), Fiber Distribution Panel (FDP), Main Distribution Frame (MDF), Uninterruptible Power Supply (UPS), AC Distribution Panel, lightning protection and grounding, HVAC, static dissipative tile (SDT) floor, Intrusion Alarm Panel, and other support systems as described in detail in this Section.

B. Design, provide and install Type I Facilities (herein after known as Houses) as described herein. Each house shall be prefabricated for communications equipment in accordance with this Section and the Contract Drawings.

C. Type II Facility is a room within a combined electrical/mechanical/communications structure, typically located within the station. Refer to the Contract Drawings for location of such room or rooms, if applicable. The Communications Equipment Room (CER) shall be dedicated to station communications and will have controlled access. Refer to the Contract Documents which indicate new or existing normal and emergency power system, fire alarm system, and HVAC system which will serve the CER. Design, provide and install all required communications equipment in accordance with this Section and the Contract Drawings.

D. Communications Facilities, Types I and II shall be equipped with proper fire extinguishers and fire monitoring systems as described in these specifications.

E. Communication Facilities Type I shall be sized and configured and Type II shall be configured based on the following guidelines:
1. An unobstructed area of open wall shall be dedicated for wall mounted termination and wiring blocks, panels, building entrance protectors, and outside plant cable splice enclosures. This area commonly referred to as the Main Distribution Frame (MDF) also serves as the MPOE termination point. Adequate space shall be planned so that initial (day-one) installation will not consume more than 50 percent of the total available MDF space.

2. Open equipment racks or cabinets shall house communication equipment, UPS, and other network and distribution equipment. Each rack or cabinet shall be assigned by system type such as network carrier, video server, or UPS. Adequate space shall be planned to allow system equipment expansion per rack or cabinet. At least 50 percent of the available mounting space of each rack or cabinet placed shall be reserved for future equipment. Should any rack or cabinet exceed 50 percent on initial installation, the facility floor plan shall reserve an empty rack or cabinet for future equipment deployment.

3. An unobstructed work clearance of three (3) feet to the front and rear of equipment racks and cabinets, and the MDF, shall be provided.

4. Adequate heating, ventilation and, if required by calculations, air-conditioning shall be sized and provided for the Communication Facilities. The HVAC equipment power and thermo calculations shall be based on the initial (day-one) installation load plus additional 50 percent of the similar load (reserved to accommodate future growth).

5. Building or room access doors shall not hinge or swing into equipment areas. The design of the building and the room access doors shall accommodate intrusion detection and access control systems.

6. The design of the building or room (including equipment to be installed inside) shall meet California Building Code (CBC), International Building Code (IBC), Uniform Building Code (UBC), Seismic Zone 4 and other requirements listed within these Specifications.

1.05 SUBMITTALS

A. Refer to Section 17000, Basic Communications Technical Requirements, for related and additional submittal requirements.

B. Preliminary Design Review (PDR) Technical Requirements:
   1. Include the following information as part of the PDR submittal package for Type 1 Communications Houses:
      a. Drawings showing the House dimensions, layout (plan and elevations), and external architecture.
      b. Architectural and Construction Details, including House and foundation reinforcing drawings.
c. Calculations signed and sealed including structural, heating/cooling, seismic (for overall building and floor, ceiling, and wall mounted infrastructure and bracing), lighting, and electrical power requirements.

d. Lightning Protection and Grounding Arrangement such as ground grid and room halo.

e. Cable Trays and Battery Racks.

f. Ac and dc Power Distribution, UPS Equipment and Lighting.

g. Fire, Access Control and Intrusion Alarm Subsystems Equipment Location, including the fire extinguisher.

h. Cable and conduit Entrance/Exit (and other protrusions) Details including firestop and water/moisture protection.

i. External Interface Details for Power and Communications Connections.

j. Plan and Elevation Drawings for MDF and wall-mount distribution panels, Equipment Cabinets, Racks, Lighting and Cable Trays.

k. HVAC equipment details.

l. Product specifications for lighting, cable trays, HVAC equipment.

m. Additional Product Data Sheets, as required for subcomponents.

n. SDT data and details.

2. Include the following information as part of the PDR submittal package for the Type II Communications Facilities:

a. Dimension drawings, plans and elevations, showing layout of equipment.

b. Ac and dc Power Distribution, including interface details for Power Connections, UPS equipment, and Lighting.

c. Calculations signed and sealed including structural, heating/cooling, seismic (for floor, ceiling, and wall mounted infrastructure and bracing), lighting and electrical power requirements.

d. Product specifications for all provided materials.

e. Fire, Access Control and Intrusion Alarm Panel equipment.

f. Plan and Elevation Drawings for MDF and wall-mount distribution panels, Equipment Cabinets, Racks, Lighting and Cable Trays.
g. Cable Trays and Battery Racks.

h. Cable and Conduit Entrance/Exit (and other protrusions) Details including firestop and water/moisture protection.

i. HVAC equipment details.

j. Grounding Arrangement such as ground grid, room halo, and Telecommunication Main Ground Bus-bar (MGB).

k. SDT data and details.

C. Final Design Technical Requirements: Submit, after Preliminary Design approval, the following information as part of the Communications Facilities Final Design submittal package:

1. Updated Preliminary Design information. All drawings, calculations and design information required for the 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 identification.

D. Installation Work Plans: Submit the following installation document for each site scheduled for installation activity. The installation Work plan shall include:

1. Site Plans and Foundation Drawings:
   a. Drawings showing plan and elevation details of the foundation and the ductbank, including the man-hole interface.
   b. Site plans for the Communications Houses.
   c. Installation Plan to include:
      i. Planned access dates and times for each location
      ii. Safety rules, regulations and procedures
      iii. Caltrain resources required
      iv. Daily preparation and cleanup procedures
   d. Delivery and Installation Procedures and Inspection Sheets:
      i. The procedures submitted shall include descriptions of the equipment used for transport and setting of the Communications Facility.
ii. Complete Inspection Sheets and submit to the Engineer within seven days after installation of the Facility.

E. Calculations and Certifications:

1. Provide calculations as listed in the Preliminary Design and Final Design. Calculations shall be signed and sealed by a California Licensed Professional Engineer.

2. Certifications: Copy of the following certifications shall be included:
   a. ISO certification for all proposed manufacturers
   b. Certificates and permits for all Facilities

F. Product Samples:

1. Provide sample color chips of the facilities finish coat for Engineer approval.

2. Provide pictures and facilitate factory visit for a typical sample Communications facility for Engineer approval.

3. Submit sample of address signage for Engineer approval.

4. Submit sample of Access Control identification for Engineer approval.

G. Manufacturer Qualifications: Submit evidence that manufacturer complies with manufacturer qualifications specified in Section 17050, Basic Communications Equipment, Materials, and Methods.

H. Test Plan and Procedures: In accordance with these Specifications, specifically with the format and requirements detailed in Sections 17000, Basic Communications Technical Requirements, and 17050, Basic Communications Equipment, Materials, and Methods, as a minimum, submit, no later than 60 days prior to the schedule test, the following plan and procedures to satisfy the Communications Facilities testing requirements

1. Test program plan: Include all the required information for the Communications Facilities in the Test Program Plan as outlined in Section 17000, Basic Communications Technical Requirements.

2. Factory and Inspection Test Procedure: Submit a complete factory test and inspection procedure to satisfy all the requirements outlined in Article entitled “Source Quality Control” of this Section.

3. Field Test Procedure: Submit a complete field test procedure to satisfy all the requirements outlined in Article entitled "Field Quality Control” of this Section.

I. Test Records: Submit the Test Records and Results for review 14 days after the completion of each test, in accordance with these Specifications.
J. As-Built Documentation: Submit complete As-Built documentation and drawings, as specified in Section 17000, Basic Communications Technical Requirements, for all Communications Facilities 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. Equipment and methods shall comply with applicable codes and standards listed under Reference Standards herein.

B. Material and Workmanship Requirements:
   1. Equipment provided under this Section shall be UL listed.
   2. Grounding shall be in accordance with local standards, Section 17060, Grounding of Communications Equipment, and these Specifications except as modified herein. Each piece of equipment shall be grounded in accordance with ANSI/TIA/EIA-J-STD-607-A.
   3. Products shall be manufactured by firms regularly engaged in manufacturing products described in these Specifications.
   4. Factory testing shall be performed by persons having five or more years of relevant testing experience
   5. Do not use discontinued product models, refurbished equipment, products at their end-of-life, end-of-sale, or end-of-service.
   6. Products specified herein are subject to the Engineer approval based on the Contractor's ability to demonstrate adherence to the requirements of these Specifications and Engineer approval of the manufacturer's quality ISO-9001 process.

PART 2- PRODUCTS

2.01 TYPE 1 COMMUNICATIONS FACILITY CONSTRUCTION

A. Structural and Architectural:
   1. Communications House shall be prefabricated, climatized, self-supporting and transportable. The houses shall be weathertight and be free from defective materials and workmanship, water leakage and seepage, and condensation.
   2. The minimum headroom inside Communication House shall be 10 feet.
   3. Communications House roof shall be fabricated from 14 gage, and walls, floor, and doors shall be fabricated from 12 gage galvannealed steel conforming to ASTM A653.
4. Following assembly, any areas exposed to outside atmosphere that have been affected by cutting or welding shall be spot galvanized with a primer that forms a dry film of no less than 90 percent pure zinc.

5. Exterior roof shall be finished with 2 to 3 mils thick white polyester powder coat. Underfloor and exterior walls shall be finished with 2-3 mils thick anti-graffiti grey polyurethane powder coat.

6. Exterior seams shall be caulked with grey RTV silicone.

7. House shall be insulated with 2 inch thick fiberglass-faced polyisocyanurate rigid insulation on walls and doors, and 4 inch fiberglass faced rigid insulation above trusses.

8. Design loading for floor shall be at least 200 pounds per square foot.

9. House shall be equipped with lifting lugs for shipping and installation.

10. Interior walls shall be covered with 3/4 inch thick MDO plywood as shown on the Contract drawings.

11. Interior walls and ceiling shall be finished with 2 coats of white fire retardant paint.

12. Steps: Reinforced concrete steps shall be provided if the lowest point of the doorway entrance is greater than one foot above ground level.

13. Doors shall be 32 inches wide and a minimum of 84 inches high. Doors shall include the following features:
   a. Hinges: Vandal-resistant bolt on stainless steel hinges with grease fittings.
   b. Lock: Heavy duty three point locking system with interior safety override handle and exterior handle with a heavy duty security hasp.
   c. Prop rod to hold door open at 90 and 160 degrees.
   d. Louvered vent with winter cover, fine copper screening, and reusable filter.
   e. Weatherstripping: Provide weatherstripping and flashing for openings such as doors and removable panels to exclude water entry under all weather conditions. Where necessary, use EDPM extruded rubber gasket providing weathertight seal.
   f. Heavy duty security hasp.

14. Flooring:
   a. Flooring shall be formed of STD, 1/8 inch thick by 12 inches square, Armstrong Excelon SDT or Engineer approved equal.
b. STD adhesive and grounding strips, followed by the tile, shall be placed directly on the floor in the manner and under the conditions recommended by the manufacturer. Tile shall be polished using the SDT polish recommended by the manufacturer. Tile color shall be submitted for Engineer approval.

c. Grounding strips to be grounded to the MGB in accordance with tile manufacturer’s recommendations.

B. Foundation:

1. The foundation system shall be pad mount style for buried or pad foundations. Concrete mix shall be as specified in Section 03300, Cast-in-Place Concrete.

2. The foundation shall be designed and installed in accordance with these Specifications.

3. The slab shall be reinforced as shown on the approved Contractor-provided design drawings. Slab reinforcement shall include provisions for leave-outs for conduit penetrations.

4. At each corner of the slab, a No. 2 AWG bare solid tinned copper ground wire shall be welded to the reinforcing bars. The other end of this ground wire shall be welded to the nearest ground rod as required by these Specifications and as shown on the site specific drawings.

C. Ductbanks:

1. Provide a ductbank from the Communications/Signals manhole to the Communications House penetrations for underground conduits. Ductbank shall be reinforced concrete as specified in Section 02500, Underground Ductwork and Structures.

2. The Contractor shall locate a plastic warning tape, as specified in Section 02300, Earthwork, between the ductbank and the finished grade surface and 12 inches above ductbank.

3. Conduit spacing within the ductbanks shall be accomplished with manufactured plastic conduit spacers.

4. All conduits within ductbanks shall be Schedule 40 PVC. Where conduits transition to occupied spaces (e.g. the Communications House), galvanized rigid steel conduits shall be used.

5. The depth of the manhole will vary from site to site. Be responsible for the excavation of ductbank as required to interface with the manhole. Provide the interface with the manhole as shown on Contract Drawings.

D. Address Signage:

1. Communications Facility shall be provided with an address signage on the side of the exterior door for identification.
2. The sign shall have a white, reflective background with 3 inch black lettering.

2.02 TYPE I COMMUNICATIONS FACILITY EQUIPMENT

A. Electrical:

1. Electric power for the Communications House shall be obtained from the Local Electrical Utility as shown on the Contract Drawings. Provide and install the cable and conduit required for the main ac feed to the Communications House as shown on the Contract Drawings.

2. Equip the Communications Facility with a 120/240Vac single phase electrical panel board rated according to the Engineer approved calculations. As a minimum, the electrical panel shall be 100 Amp panel board. A transient voltage surge suppressor, meeting the requirement of NEC Article 280, shall be provided for the panel board. The electrical panel shall be equipped with a main circuit breaker rated according to the Engineer approved calculations. As a minimum, a 100 Amp main circuit breaker shall be provided. Sixteen branch breaker slots shall be provided with a minimum of 16 breakers equipped. Breakers shall be labeled with the corresponding equipment or system circuit feeds. One (1) 120/240 Vac EPD surge protector shall be provided.

3. Duplex 20A receptacles shall be provided at intervals of approximately 6 feet along walls. Electrical boxes shall be in accordance with these Specifications.

4. L5-30 locking 30A receptacles shall be provided where required by the specified Uninterruptable Power Supply (UPS).

5. Six (6) fluorescent tube fixtures, 24 inches in length, with 4 tubes per fixture and wrap lens, shall be provided.

   a. The light level shall be adequate for reading with an average level of 50 foot-candles.

   b. A 20A SPST light switch located adjacent to the door shall operate the fixtures.

6. All indoor power cable runs shall be in electrical metallic tubing (EMT) conduit and secured with single-hole straps.

7. Two electro-tin plated solid copper grounding buss bars, the Telecommunications Main Grounding Bus-bar (MGB), shall be installed at a height of 18 inches, and attached with insulated brackets as required by these Specifications. Equipment, cables, racks, and cable trays, shall be grounded to this buss-bar as required by these Specifications and the Contract Drawings.
8. Ground test stations shall be provided, along the bottom and inside wall of the house and shall be interconnected by an insulated copper cable sized at no less than 250 kcmil.

9. UPS and batteries as required by these Specifications.

10. A separate 120V ac power panel shall be provided for power output from the UPS. Main lugs rated at 225 Amp shall be provided. Thirty breaker slots shall be provided with a minimum of 12 breakers equipped. All active slots shall be labeled with the equipment to which the circuit feeds. Ac power to individual equipment racks shall be individual home runs from the UPS breaker panel, and shall be enclosed in EMT conduit.

11. A Main Distribution Frame (MDF) shall be provided at the entrance way for the cable entrance conduits as shown on the Site specific drawings. The MDF shall conform to these Specifications.

12. Equipment cabinets shall be provided for and equipped complete with communication equipment as required on the Contract Drawings. Cabinets shall conform to these Specifications and site specific drawings.

13. FSE shall be provided as shown on the site specific drawings. Enclosure shall conform to these specifications.

14. A room halo ring ground shall be provided. The halo shall be made from No. 4 AWG bare stranded copper conductor, and be bonded to the MGB as required by these Specifications.

15. A 120 Vac battery backup green Light Emitting Diode (LED) type exit light shall be provided and installed over the doorway. The LED lamp life shall be rated for 25 years. The battery shall be a Ni-cad type and shall have 90 minutes capacity.

16. Telephones shall be installed and tested as required by these Specifications and the Contract Drawings.

B. Heating, Ventilation and Air Conditioning (HVAC): Equip communications house with HVAC equipment rated according to the approved thermo calculations in the design submittals. As a minimum, HVAC equipment shall be equipped with a thermostatically controlled 5000 watt resistant heater and 18,300 BTU air conditioner. Temperatures within the house shall be regulated within the range of 60 degrees Fahrenheit (F) to 80 degrees F with ambient temperatures in the range specified by the Specifications.

1. The temperature within the equipment cabinets shall not exceed ambient air temperature within the house by more than 10 degrees F.

2. The outside of each air conditioner shall be protected with a hinged, heavy gauge, hot-dipped, galvanized vandal-resistant security mesh cage. The cage shall be constructed with a slot on the frame that, when in its closed position, will not pinch the air conditioner's condensation drainage tube.
a. The cage shall be constructed of an angle iron frame and be enclosed with 1-1/2 inch x 10-gauge steel expanded metal to form a five-sided box.

b. The cage shall be hinged to swing horizontally open to allow for 90 degrees maintenance access. Two locking hasps shall be provided to hold the cage in the closed position. A mechanical device shall be provided for securing the cage in the 90 degrees opened position. Cage design shall allow for a single maintenance technician to gain access and perform any maintenance activity on the HVAC unit.

c. The cage shall be attached to the wall using tamper-proof screw/bolts with anchors cast into the wall during manufacturing to ensure mounting integrity.

d. The cage shall have an oversized width, additional 1 foot minimum, on the hinged right side to accommodate air conditioner maintenance.

3. An exhaust fan with manual and thermostatic control shall be provided. The thermostatic control of the exhaust fan shall prevent simultaneous operation of the fan and air conditioner Compressor. The exhaust fan shall include rain hood and controlled louvers with 1/4 inch wire mesh screen. The fan shall be rated according to approved thermo calculations and shall as a minimum have 1000 CFM capacity.

4. All penetrations through the walls, floor, and roof shall be sealed to prevent water from entering the House.

5. The HVAC system shall provide separate alarm contacts for unit failure and both high and low temperature, which will be connected to the local UPS Alarm dry contacts (and to RTU in the future) and programmed for monitoring. An LED indication shall be provided within the House to show when the alarm is active.

6. The HVAC system, upon a Fire Alarm condition as detected by the House’s Fire and Intrusion Alarm Subsystem equipment, shall automatically and within four seconds, initiate actions to:

   a. Shut off the air conditioning unit(s)

   b. Close dampers

C. Cabinet Ventilation: Cabinets that contain heat-generating equipment shall be provided with adequate ventilation. In particular, cabinets and compartments housing essential electronic equipment, shall be designed to provide adequate ventilation so that for any device inside its maximum temperature stays below its rated operating temperature with a margin of at least 10 degrees Celsius. If required in order to avoid overheating, the Contractor shall provide forced air ventilation inside such enclosures, including alarms.
D. Cable Tray: Cable trays shall be provided in accordance with the Engineer approved House layout plans. Cable trays shall be as required in the Specifications and Contract Drawings.

E. Fire and Intrusion Alarm Subsystems: Provide fire detection and alarm system conforming to NFPA 72E, complete with ionization detectors, dual ion zone module, control panel, end-of-line device, power supplies and all other items of material and equipment required for a complete installation. The Fire and Intrusion Alarm Subsystems, shall be installed and tested as required by the Specifications.

F. Equip house with a 20 pound dry chemical fire extinguisher.

G. Exterior lighting shall include a weatherproof, wall mounted area lighting fixture above each doorway. The exterior lighting shall be on a separate circuit, and shall be controlled by a switch with three positions as follows: ON, OFF and AUTO. In the AUTO position, the exterior lighting shall be controlled by a photoelectric cell.

H. Communications System Equipment: Additional communications system equipment such as LAN/WAN, PAS, VMS, TVM, Clipper CID and/or CCTV, including all related hardware integral with the cabinets, shall be installed in the communications house as shown on Contract Drawings and as described in the Specifications.

2.03 TYPE II COMMUNICATIONS EQUIPMENT FACILITIES

A. Provide and install the following equipment at each Type II Facility:

1. UPS and batteries as required by the Specifications.

2. A 120V ac power panel fed from the output of the above UPS. Panel shall have 30 breaker slots and be provided with a minimum of 12 breakers sized as shown on the Contract Drawings.

3. An electro-tin plated solid copper grounding buss-bar, the Telecommunications Main Grounding Bus-bar (MGB), shall be installed at a height of 24 inches, attached with insulated brackets as required by the Specifications.

4. Equipment, cables, racks, and cable trays shall be grounded as required by these Specifications and the Contract drawings.

5. A Main Distribution Frame (MDF) shall be provided at the entrance way for the cable entrance conduits as required by these Specifications and as shown on the Contract Drawings.

6. FSE shall be provided as shown on the Contract Drawings. Enclosures shall conform to the Specifications.

7. Fiber Distribution Panel (FDP) shall be provided as required by these Specifications and as shown on the Contract Drawings.
8. A room halo ground ring shall be provided. The halo shall be made from No. 4 AWG bare stranded copper conductor, and be bonded to the MGB as required by the Specifications.

9. Cable trays shall be provided in accordance with the Authority approved facility room layout plans. Cable trays shall be as required by these Specifications and the Contract Drawings.

10. Equipment cabinets shall be provided for and equipped complete with communication equipment as required by the Specifications and Contract Drawings.

11. Equipment cabinets shall have fans located in the top to provide for air circulation. Cabinet ventilation openings shall have replaceable filters to prevent the intrusion of dirt.

12. Access Control and Intrusion Alarm Control Panel equipment shall be installed and tested as required by the Specifications.

13. Fire detection equipment (as an integral part of the combined facility fire detection system), including the fire extinguisher shall be provided in accordance with the Specifications.

14. Telephones shall be installed and tested as required by these Specifications.

15. Flooring: As specified for Type 1 Communications Facility Construction in this Section.

16. All exposed wiring shall be run in conduits as required by these Specifications.

17. A 120Vac battery backup green LED type exit light shall be provided and installed over each doorway. The LED lamp life shall be rated for 25 years. The battery shall be a NiCad type and shall have 90 minutes capacity.

18. Electrical service equipment shall include the following:
   a. HVAC equipment
   b. Interior Lighting
   c. Access Control, Fire Detection and Alarm system
   d. MGB and related grounding cables

B. Cabinet Ventilation: Cabinets that contain heat-generating equipment shall be provided with adequate ventilation. In particular, cabinets and compartments housing essential electronic equipment shall be designed to provide adequate ventilation so that for any device inside its maximum temperature stays below its rated operating temperature with a margin of at least 10 degrees Celsius. If
required in order to avoid overheating, the Contractor shall provide forced air ventilation inside such enclosures, including alarms.

C. Communications System Equipment: Additional communications system equipment such as WAN/LAN, PAS, VMS, TVM, Clipper CID, and/or CCTV, including all related hardware integral with the cabinets, shall be installed in the communications house as shown on Contract Drawings and as described in the Specifications.

2.04 SOURCE QUALITY CONTROL

A. Monitor the fabrication of the Houses to ensure that all structural requirements are adhered to.

B. Inspection: Inspect the Communications House prior to shipment to a site. Notify the Engineer no later than 21 days prior to this inspection.

C. Perform the following Factory Inspection (Communications Facilities, Type 1 only). Provide the Engineer at least 21 days written notification prior to each test and inspection.

1. Provide Factory inspection procedure for Authority approval at least 21 days prior to scheduled inspection.

2. Inspect the House at the Factory for cracks and other damage, and repair to the satisfaction of the Engineer.

3. Inspect the House at the Factory for level and plumb; proper operation of doors and dampers; proper location and installation of HVAC equipment breaker panels, lighting fixtures, electrical outlets, fire and intrusion sensors and equipment; cable trays, and other equipment.

4. Inspections shall verify:
   a. Conformance to standards, methods, and quality.
   b. Correct location, positioning, seating, mounting, orientation, and labeling.
   c. Secured cable and wire connections.
   d. Proper routing and termination of wire and cable.
   e. Proper equipment grounding.
   f. Correct and complete labeling and tagging of wire, cable, terminal, connectors and equipment.
   g. Conformance to installation requirements.

5. Provide inspection results for Engineer approval 14 days after the completion of an inspection,
PART 3 - EXECUTION

3.01 INSTALLATION

A. Foundation and Placement of the Communications House:

1. Perform site preparation in accordance with Section 02110, Site Clearing.

2. Refer to Section 02300, Earthwork, for requirements for excavation and backfill for the Communications House site.

3. The foundation and anchor bolt locations shall be of depth and size to support the prefabricated shelter in accordance with the approved drawings. Concrete formwork and concrete reinforcement shall be in accordance with Contractor-provided design and Division 3, Concrete, Specifications Section.

4. Install the House level and plumb on the foundation. Apply waterproof, non-hardening sealing compound between the foundation and house base perimeter.

5. Provide and install a ballast skirt surrounding the House. The skirt material shall be consistent with the ballast specified in Section 20110, Ballast and Walkway Aggregate. Ballast shall be a minimum depth of 12 inches and at least five feet wide, extending from the communication house foundation outward and consistent with the other wayside structures sharing the common location.

6. A ballast path shall extend from the Communications House door to the nearest driveway, parking area, or improved access point. The path material shall be consistent with the ballast specified in Section 20110, Ballast and Walkway Aggregate. Ballast shall be a minimum depth of 12 inches and at least 3 feet wide, and consistent with the other wayside structures sharing the common location.

B. Cable Entrance Conduits:

1. Install eight 4-inch schedule 40 PVC conduits from a Communication System Manhole (CSMH) to the House, and stubbing up through the House floor foundation. As the conduits enter the communications house, provide a matching coupling and Galvanized Rigid Steel (GRS) conduit above the floor. Provide an additional conduit, for ground conductors, which will pass through the slab and extend approximately 18 inches beyond the edge of the slab. These conduits shall be installed in the pattern provided on site specific drawings and as required by the Specifications.

2. The cable entrance conduits shall sweep into the House through the foundation. The sweep radius at the entrance conduits shall be greater than the minimum radius required for the fiber optic cable as required by these Specifications.
3. The entrance conduits shall be encased in a concrete reinforced ductbank as shown on the Contract Drawings and as required by these Specifications. Provide the interface with the CSMH as shown on Contract Drawings.

4. Seal around the conduits with a permanent, waterproof and fire-stopper sealing compound as required by these Specifications. After all cables have been installed, fill the conduit openings with fire-stopper duct sealant in order to prevent moisture from entering the House.

5. The cable entrance conduits shall be as required by these Specifications.

C. Grounding:

1. Install, as a minimum, one ground rod outside each corner of the House, and the connecting ground wire, as shown on the Contract Drawings.

2. Grounding shall be as required by these Specifications and the Contract Drawings.

3. The electrical power systems shall be grounded as required by these Specifications, and as shown in the Contract Drawings.

3.02 FIELD QUALITY CONTROL AND TESTING

A. Perform the following field inspections and tests on all Communications Facilities. Give the Engineer at least 21 days written notification prior to each test and inspection.

1. Field Inspection:
   a. Prior to installation, inspect with the Engineer the foundation and conduit stub-ups and anchors to verify that they conform to Contract Drawings. Record discrepancies on a discrepancy list; immediately submit the list to the Engineer; and proceed to correct discrepancies.
   b. Field inspection shall include inspection of each installed communications facility. Process inspections are required.
   c. The inspection shall confirm that:
      i. The installation drawings and procedures define the installation adequately and in sufficient detail, such that if the procedures are followed, the resulting installation will meet Engineer approved standards, practices and procedures for workmanship, maintainability, referenced installation standards, installation requirements, these Specifications, the site specific drawings, and the installation requirements of local jurisdictions.
      ii. Should the Engineer decide that the installation drawings and procedures are inadequate, revise any such
drawings and procedures prior to performing installation Work.

iii. The installation drawings and procedures shall adequately provide for the safety of installation personnel. If not, the installation procedures shall be revised prior to performing installation Work.

d. Inspection shall verify:
   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.

e. Provide all the inspection records and results required in this Section to the Engineer within 14 days after each inspection.

2. Field Tests: Perform the following field tests:
   a. Verify operation of main circuit breaker and all feeder circuit breakers.
   b. Measure resistance to ground from all ground points, including those located in equipment cabinets. Measured resistance shall not exceed 3 ohms as required by these Specifications.
   c. Verify operation of all lighting.
   d. Verify operation of HVAC equipment, including heaters, air conditioner, exhaust fan as well as all thermostatic controls.
   e. Verify operation and reporting of the communications facility alarm indications including those related to fire, intrusion, power and HVAC (visual and audio) both locally and at the Central Control Facility (CCF).
   f. Verify operation of dampers and HVAC unit in the event of fire alarm conditions.
   g. Verify operation of all equipment controls and indicators.
   h. Provide all test records and results required in this Section to the Engineer within 14 days after each test.
B. End-To-End Acceptance Test: Acceptance testing will be limited to the field tests described above. There is no requirement for End-to-End Acceptance Test for the Communications Facilities.

C. System Integration Test: System Integration Test will be directed by the Engineer. Provide qualified technical staff to support this test as required by these Specifications and the Engineer.

END OF SECTION
SECTION 17120
COMMUNICATIONS WIRES AND CABLES

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes requirements for wires and cables, cable connectors, and other related materials.

1.02 REFERENCE STANDARDS

A. American National Standards Institute (ANSI):
   1. ICEA S-87-640 Fiber Optic Outside Plant Communications Cable
   2. J-STD-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

B. American Railway Engineering and Maintenance of Way Association (AREMA):

C. ASTM International (ASTM):
   1. B3 Specification for Soft or Annealed Copper Wire
   2. D1248 Specification for Polyethylene Plastic Extrusion Material for Wire and Cable
   3. D4101 Specification for Propylene Injection and Extrusion Materials
   4. E814 Test Method for Fire Test of Through - Penetration Fire Stop

D. Building Industries Consulting Services International (BICSI):
   1. Telecommunications Distribution Methods Manual (TDMM)

   1. 7 CFR 1755.890 RUS Specification for Filled Telephone Cable with Expanded Insulation
   2. 7CFR 1755.900 RUS Specification for Filled Fiber Optic Cables
   3. 7CFR 1755, Bulletin 1753F-201 RUS Specification for Acceptance Tests and Measurements of Telecommunications Plant

F. Code of Federal Regulations, Railroad Administration (FRA)
G. California Build Code (CBC)
H. California Electric Code (CEC)
I. Electronics Industries Alliance (EIA):
   1. 310 Cabinets, Racks, Panels, and Associated Equipment
J. Institute of Electrical and Electronic Engineers (IEEE):
   1. National Electrical Safety Code (NESC)
K. Insulated Cable Engineers Association, Inc. (ICEA):
   1. S-84-608 Filled Telecommunications Cable, Polyolefin, Insulated, Copper Conductor
L. National Electrical Contractors Association (NECA):
   1. 1 Standard Practices for Good Workmanship in Electrical Construction
M. National Electrical Manufacturers Association (NEMA):
   1. WC 7 Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
   2. WC 70 Nonshielded Power Cables Rated 2000 Volts or less for the Distribution of Electrical Energy
   3. WD 1 General Requirements for Wiring Devices
N. National Fire Protection Agency (NFPA):
   1. 70 National Electrical Code (NEC)
   2. 70E Electrical Safety in the Workplace
   3. 72 National Fire Alarm Code
   4. 75 Protection of Electronic Computer Data Processing Equipment
   5. 101 Life Safety Code
   6. 130 Fixed Guideway Transit Systems and Passenger Rail Systems
   7. 262 Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
   8. 780 Installation of Lightning Protection Systems
O. Telecommunications Industry Association/ Electronics Industries Alliance (TIA/EIA):
1. 455 Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices and Other Fiber Optic Components

2. 492CAAB Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak

3. 568 Commercial Building Telecommunications Cabling Standard

4. 569 Commercial Building Standard for Telecommunications Pathways and Spaces

5. 606 Administration Standard for the Telecommunications Infrastructure

P. Telecommunications Industry Association (TIA):
1. 598 Optical Fiber Cable Color Coding

Q. Underwriters Laboratories (UL):
1. 444 Communication Cables

2. 497 Standard for Safety Protectors for Paired Conductor Communications Circuits

3. 969 Standard for Marking and Labeling Systems

4. 1581 Reference Standard for Electrical Wire, Cable, and Flexible Cords

5. 1690 Data-Processing Cable

1.03 SYSTEM DESCRIPTION

A. Material and workmanship of the cables shall be consistent with the following requirements:

1. The life expectancy of the cable shall be minimum 40 years in a railroad environment.

2. The cable shall be constructed for continuous operation at 90 degrees Celsius, in a wet or dry environment.

3. Conductor to conductor and conductor to ground resistance shall not be less than one mega-ohm.

4. Cable shall be constructed for continuous operation at minus 40 degrees Celsius without cracking or becoming brittle.

B. Design, installation, and testing shall comply with all applicable standards and codes listed under Reference Standards in this Section. The installation of power wire and cable shall conform to all applicable NEC standards. Installation of data
and communication cable shall conform to all applicable RUS and TIA/EIA standards.

1.04 SUBMITTALS

A. Refer to Section 17000, Basic Communications Technical Requirements, for related and additional submittal requirements. Submit additional submittals upon Engineer’s request.

B. Submit product data wires and cables including complete technical information for each type cable.

C. Submit Conduit fill calculations not to exceed the NEC specified fill ratios.

D. Submit wire size calculations for all copper cables to determine voltage drops, and proper capacity for voltage, current and distance for all feeder, branch and device power; Ethernet (and, if applicable, serial) data and audio applications.

E. Submit a written cable installation procedure and check-off list for approval prior to cable installation. Prepare procedure based on Contractor’s review of the conduit plans, and field site survey and shall include a cabling plan and installation information for each cable pull. The installation plan shall include proper procedures for feeding cable into conduit to maintain proper bend radii, and to minimize friction. The documentation shall include details of cable lightning/surge protection and grounding.

F. Identification Submittals: Submit wire designations scheme for the Engineer’s approval. Submit sizes of letters and nature of wording for labels, number plates, and warning notices.

G. Submit cable test plan at least 30 days in advance of testing: tests to be made, format and layout of test forms and reports, and the limiting values to be used.

H. Submit manufacturers’ qualifications.

I. Submit certified test reports.

J. As-Built Documentation: Refer to Section 17000, General Communications Technical Requirements, for requirements. Show all terminations, wire and cable labels/numbers, with interconnected equipment.

1.05 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with all applicable codes and specifications.

B. Manufacturer Qualifications: Obtain Engineer’s approval of all wire and cable manufacturers. Provide data required for evaluation, and make arrangements for any demonstrations and tests required by the Engineer.

C. Qualifications shall be based on the following criteria:
1. **Past Performance and Experience:** The cable manufacturer(s) shall demonstrate previous successful experience in supplying wire and cable specified herein. A list of such installations shall be provided for each cable manufacturer to be considered.

2. **Quality Assurance Program:** The cable manufacturer(s), in accordance with the requirements of these Specifications, is required to have in place or implement, an effective quality assurance program adhering to the requirements of ISO 9001 to ensure purchase control performance. The Engineer’s inspection of manufacturing facilities may include first article inspections, source inspections, and on-site surveys.

3. **Technical Data:** Provide full technical data that demonstrates compliance with the requirements of these Specifications for each specified cable type proposed to be supplied.

**1.06 PRODUCT DELIVERY, HANDLING AND STORAGE**

**A. Packing:** All cable barrels/spools/drums shall not be less than twenty (20) times the finished cable nominal diameter, but not less than the minimum bending radius. Seal all ends of the cable to prevent entrance of moisture.

**B.** The following particulars shall be stenciled or painted in a permanent manner on the outside of the flange of each drum.

1. Metallic cable shall have the words “Telecommunication Cable”
2. The manufacturer’s identification of the cable type and date of manufacture
3. Gross weight of Reel and Cable
4. Full description of the cable
5. Cable identification number, which is referenced to the test sheet
6. Length of Cable
7. An arrow showing the direction in which the drum should be rolled to gain access to the cable.

**C.** Handling: Cable drums shall be complete with close fitting wooden battens to prevent damage to the cable during transit and storage.

**D.** Acceptance at Site: Examine drums at installation storage area for external damage. Damaged cables will not be accepted. Inspect cables at time of delivery to the construction site to assure that no damage was done in shipping and that the specified cable was received. Inspect every reel for physical damage such as nails driven into reels to secure shipping blocks, lagging, or reel covering missing and cable and seals missing or damaged. Replace promptly all damaged or rejected cable. Conduct fiber loss (OTDR) testing on the fiber cable and continuity and cross-talk testing for the copper cabling to ensure all delivered cabling is within the vendor specified performance range upon arriving.

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to the site. All defective and/or underperforming cables shall be returned and
substituted with the product meeting specifications. Provide to the Engineer the
results of the delivery acceptance tests.

E. Storage and Protection: Store drums with flanges upright. Store cable on drums
with batten in place indoors. Store wires and cables at the construction site on
solid surfaces, which shall adequately support the cable reels, but which shall be
well drained and not allow accumulation of liquids, oils, or chemicals.

F. Align and protect cable reels so as not to allow the reel flanges to damage other
reels. Provide adequate aisles and barricades to allow for accessibility but
prevent construction equipment from damaging the cable reels.

PART 2 – PRODUCTS

2.01 DATA CABLE

A. Local distribution of data circuits for all system shall be by CAT 6 cable.

B. Single-mode fiber shall be used to connect the main cabinet and all distribution
(and any other) cabinets throughout the station.

C. Single mode fiber shall be used for all communications purposes outside of the
station facility.

D. All installed copper and fiber cable throughout the station shall be outdoor type.
Unless rated as outdoor/indoor cable type, all outdoor cabling past 50 feet from
the point of entrance into the facility shall be switched to the indoor type. All
outdoor cabling containing metallic (conductive) elements shall be properly
lightning/surge protected at the point of entrance into the facility or cabinets
according to NEC and also requirements found within these Specifications.

E. Wire conductors shall be composed of soft or annealed copper, meeting
insulating, and sensitivity and elongation requirements of ASTM B3. Joints made
in conductors during manufacturing may be welded or brazed using silver alloy
solder and non-acid flux.

F. The insulation shall be colored virgin propylene copolymer meeting the
requirements of ASTM D4101, or equivalent, for propylene plastic. High
molecular weight polyethylene is also acceptable.

G. All outside communication cables (those run in conduits or duct banks) shall be
foam/skin insulated conductors that meet RUS Specification 7 CFR 1755.890 and
shall be rodent protected.

H. Inside wire (wiring run within any building) from telephone terminals to
telephone instruments shall be 22 AWG or 24 AWG and have a characteristic
impedance of 105 ohms plus or minus 15 percent. Cable shall be low smoke,
non-toxic, Teflon.

I. Communications cables shall be type and size (number of pairs) identified for the
installation of the various communications systems.
J. Communications cables shall be UL Listed and Approved for intended use. All cable shall be of Type specified by the NEC for use in plenum, non-plenum, and riser spaces.

K. Communications cable suitable for use in ducts, plenum, and other space used for environmental air shall be UL Listed as being smoke resistant, shall be Teflon-coated and shall be classified as type CMP communications cable.

L. Communications cable suitable for use in vertical shafts shall be UL Listed for use in such space and shall be classified as type CMR communications cable.

2.02 UTP CAT 6 CABLE

A. Category 6 cable shall meet the following requirements:
   1. Polyethylene sheath
   2. Low smoke, rated for 90°C

B. All UTP CAT 6 connections shall comply with standards per TIA/EIA-568

2.03 UTP CAT 6 CABLE (AERIAL)

A. Aerial outside plant CAT 6 shall meet the following requirements:
   1. Polyethylene sheath
   2. Low smoke, rated for 90°C
   3. Suitable for aerial application

2.04 COAXIAL CABLE

A. Where required, provide coaxial cables for video transmission; 75 ω characteristic impedance; double braided copper shield and a 20 AWG solid copper center conductor, manufactured for the intended purpose.

B. Types: RG6 and RG11. Do not use other types.

C. Where required, coaxial cable used for the CCTV system shall meet the following characteristics:
   1. Jacket: NEC CL2P Plenum Rated
   2. Wires: Uniquely Color Coded
   3. Shield: 1 overall foil shield, with a braided shield minimum
   4. Capacitance: ≅ 53.2 pF/M
   5. Resistance: ≤ 10 ohms/100 M

C. At no time subject any coaxial cable to a bend of less than 6-inch radius.
2.05 RS-485/RS-422/RS-232D DATA CABLE

A. RS-485/RS-422/RS-232D Data Communication Cable. If required, serial data cables used for RS-422, RS-485, or RS-232D balanced electrical transmission of data shall meet the following characteristics:

1. Jacket: NEC CL2P Plenum Rated, Low Smoke
2. Wires: Uniquely Color Coded
3. Cable Type: Twisted pair
4. Conductor gauge: 24 AWG (7 X 32 AWG) stranded, minimum
5. Shield: Individually foil shielded pairs each with a drain wire; and one overall foil shield, with a braided shield minimum
6. Capacitance: \( \leq 13 \text{ pf/ft} \) (12 pf/ft for RS-232D)
7. Resistance: \( \leq 16 \text{ ohms/1000 ft} \) (30 ohms/1000 ft for RS-232D)

2.06 FIBER OPTIC CABLE (ALL DIELECTRIC)

A. New outside plant (OSP) all dielectric single-mode fiber optic cable (FOC) shall be furnished and installed between the Communications Equipment Room (CER) and field Distribution Cabinets (DC) without intermediate distribution or cross-connects. Multi-mode cable can only be used as an exception and only if approved by the Engineer. Such cable shall be outside plant and all dielectric.

B. Dielectric single mode (and, if used, multi-mode) fiber optic cable shall be furnished. All fiber optic strands shall be terminated with SC-type connectors. All fiber strands shall appear at assigned demarcation panels, including spare (dark) fibers.

C. General: All outside plant FO cable shall be certified to meet applicable tests of TIA/EIA-455.

D. Construction:

1. Each fiber buffer tube will be color-coded so as to provide unique and permanently visible identification. Color coding shall be in accordance with TIA/EIA-598.
2. A dielectric strength member shall be central to the cable core.
3. The cable shall be designed for outdoor use and be waterproof, including water-proof tape and/or gel-filled.
4. The shipping length of cable shall be permanently identified by printing on the outer surface of the jacket, at intervals of 5 ft or less. Information is to include count of fibers, fiber type and size, cumulative footage markers, manufacturer's designation and manufacturer's name.
5. Design and construction shall recognize the nature of fiber optic cables regarding installation, especially at manholes. Allowance for such fiber characteristics shall be made in cable pull budgets.

E. Single-Mode Optical Fiber Characteristics:

1. Fiber Type: Class IVa Dispersion; Unshifted Single-mode fiber, compliant with TIA/EIA-492CAAB
2. Core Diameter: 8.3 microns (nominal)
3. Mode Field Diameter: 8.7 - 9.5 microns
4. Cable Cut-off Wavelength: < 1250 nm
5. Maximum Attenuation: 0.4 dB/km @ 1310 nm, 0.3 dB/km @ 1550 nm
6. Zero Dispersion Wavelength: 1300 - 1322 nm
7. Zero Dispersion Slope: < 0.095 ps/(nm2-km)
8. Gigabit Ethernet distance guarantee: 1,310/1,550 nm-5,000 meters

F. Cable Mechanical Specifications:

1. Nominal Jacket Wall Thickness: 0.055 in
2. Maximum Tensile Load Rating - Installation: 600 lbs
3. Maximum Tensile Load Rating - Maintained: 100 lbs

G. Maximum attenuation variation during operation minus 40 degrees C to plus 65 degrees C, installation (minus 30 degrees C to plus 60 degrees C), and storage (minus 50 degrees C to plus 70 degrees C):

1. Multimode fibers: plus 0.50 dB/km at 1300 nm
2. Single-mode fibers: plus 0.20 dB/km at 1550 nm

H. Cable Markings:

1. Imprinted with white characters on the outer cable jacket
2. Permanent, insoluble in water and legible for the cable life
3. Imprint the following identification markings on the cable jacket at intervals of not more than one meter:
   a. Manufacturer
   b. Year of manufacture
   c. "OPTICAL CABLE"
   d. Manufacturer's part number
I. Fiber Connectors:
   1. Connectors shall be SC type
   2. Optical parameters of the connectors shall meet the requirements of TIA/EIA-568

2.07 AERIAL FIBER OPTIC CABLE

A. New outside plant (OSP) single mode gel-filled loose tube optical fiber cable shall be installed if the fiber is not in conduit.

B. Fiber optic cable shall be manufactured for aerial applications with a messenger wire.

C. The fiber optic cable shall comply with IEEE 802.3z.

D. General: All outside plant aerial FO cable shall be certified to meet applicable tests of TIA/EIA-455.

E. Construction:
   1. Each fiber buffer tube is color-coded to provide unique and permanently visible identification. Color-coding shall be in accordance with TIA-598.
   2. A dielectric strength member shall be central to the cable core.
   3. The cable shall be designed for outdoor use and be waterproof, including waterproof tape and/or gel-filled.
   4. Each shipping length of cable shall be permanently identified by printing on the outer surface of the jacket, at intervals of 5 ft or less. Information is to include count of fibers, fiber type and size, cumulative footage markers, manufacturer's designation and manufacturer's name.
   5. Central strength member shall be PE Covered Glass Reinforced Plastic.
   6. Messenger Wire: Flooded Stranded EHS Steel

F. Fiber Connectors:
   1. Connectors shall be SC type
   2. Optical parameters of the connectors shall meet the requirements of TIA/EIA-568

2.08 SINGLE-MODE FIBER OPTIC PATCH CORDS (FAN OUT ASSEMBLY)

A. General:
   1. Described as a pre-connectorized (one end only) single mode fiber optic pigtails, suitable for splicing distribution SM fiber strands to termination equipment.
2. Glass optical core fiber with a core cladding of low density glass concentric about the optical core, a protective acrylate buffer coating, and a PVC loose tube buffer to protect the outer surface of the fiber.

3. Tensile strength member: Aramid fiber applied over the buffered fiber followed by a PVC outer jacket.

4. Factory-terminated on one end with an SC-type fiber optic connector.

5. Field determined length for each patch cord, minimum 6 ft.

B. Optical Fiber Specifications

1. Buffer Diameter: 900 microns

2. Maximum Connector Insertion Loss: 0.5 dB

3. Connector Return Loss: < minus 55 dB

C. Patch Cord Mechanical Specifications

1. Nominal Cable Diameter: 0.12 in

2. Maximum Tensile Load Rating - Installation: > 100 lbs

3. Maximum Tensile Load Rating - Maintained: > 50 lbs

4. Minimum Bending Radius - Installation: < 2.0 in

5. Minimum Bending Radius - Maintained: < 1.5 in

6. Crush Resistance: > 400 lbs/in

7. Impact Resistance: > 1,000 cycles

8. Flex Resistance: > 7,500 cycles

9. Cable Length: 6.0 ft (minimum), or as determined by Contractor and approved by Engineer

10. Patch Cord Termination

11. One end of the fiber optic patch cord shall be factory-terminated with a SC-style connector with a strain relief boot with no terminations on the other end.

12. Ferrule Material: Zirconia Ceramic

2.09 PUBLIC ADDRESS SYSTEM CABLES

A. Audio Cable shall be utilized to connect the Public Address output amplifier with all platform and station speakers to meet the following characteristics:
1. Speaker Cable shall be two pair.

2. Shielded outdoor rated copper cable with outer shield drain wire.

3. Shields shall be terminated only at the cabinet.

4. Minimum of 16 AWG shall be used between speakers and cabinet termination. Minimum of 12 AWG shall be used between output amplifier and cabinet termination. If required by the PA load and voltage drop calculations, the Contractor may be required to utilize PA cabling of a bigger diameter than specified within this paragraph above.

5. Conducting wires shall contain minimum of 7X26 strands.

6. The design of the outer jacket shall correspond to indoor or outdoor types of applications.

B. Microphone cable shall be two pair 18 AWG stranded twisted pair with shield.

C. Local distribution cables for the PA system shall be placed in separate conduit or raceways from low-level voice and data circuits. Cable jacket shall have 600-volt rating.

2.10 T1 AND CATEGORY 6 DATA COMMUNICATIONS CABLE

A. The cable for connection of DSX-1 compatible signals shall be Western Electric ABAM or Engineer approved equal.

B. Cable jacket shall be low smoke and rated for the environment installed.

C. Wires will conform to PIC color code, type twisted pair, with conductor gauge solid annealed.

D. Each cable copper pair will be individually shielded with drain wire.

E. Characteristic impedance will be 100 ohms @ 772 khz, with mutual capacitance at 90 nf/mi.

F. Category 6, 4-pair data cable shall be solid conductor when used in horizontal distribution per TIA/EIA 568. Cable shall be stranded pair when used as patch cords for local equipment connectivity.

2.11 LABELS AND TAGGING

A. All labels, number plates and warning notices shall be of durable and corrosion resistant materials securely fitted by permanent means and clearly worded. For outdoor use they shall remain legible and not suffer degradation throughout the expected life of the equipment. Labels, number plates, and warning notices shall have black lettering on a white background.

B. Marking tags for wires and cables shall be permanent and non-conducting which securely fasten to wires and cables. Wrap-on tags are not acceptable.
1. **Sleeve Type Tags**: Tags for identification of individual cable conductors and field-installed wires within equipment cabinets shall be the sleeve type.

2. **Flat Plastic Tags**: Tags for identification of multi-pair or multi-conductor cables shall be the flat plastic laminated types.

3. Tags shall be one and one-half inches long by three-quarter inch wide with one, five-sixteenth inch hole located in the center of the width. The untreated tag shall be milk white "vinylite" or Engineer approved equal.

4. The identifying nomenclature space shall allow for three rows of lettering, and the tag material shall be capable of receiving typed-on characters by conventional means. The height of the lettering shall not be less than one-eighth inch.

5. Tags shall be the type that after lettering, both the face and back side of the tag shall be covered with a clear plastic coating, "vinylite", or Engineer approved equal.

### 2.12 SOURCE QUALITY CONTROL

**A.** Monitor the manufacturer(s) of the wire and cable to ensure that the approved Quality Assurance Program is being closely adhered to and that the wire and cable is being manufactured in accordance with these Specifications and the Engineer approved submittals.

**B.** Each finished wire and cable shall be traceable to the test date on file for each step in its manufacturing process.

**C.** Factory Testing of Fiber Cables:

1. Test each fiber optic cable strand on-reel prior to shipment and prior to placement on-site.

2. Record end to end loss for each fiber at 850/1300 nm for multimode and 1310/1550 nm for single mode.

3. Optical Time Domain Reflectometer (OTDR) with hardcopy record shall be provided for each fiber.

4. Test optical dispersion for each fiber.

5. Submit certified copies of tests results to the Engineer.

### PART 3 – EXECUTION

#### 3.01 INSTALLATION

**A.** Furnish and install all necessary junction boxes, pull boxes, connectors, ceiling wires, supports, cable and wire to provide a complete and reliable system. All equipment shall be properly protected from the exposure to the elements according to the manufacture recommendations and to ensure ease of future
maintenance. After installation, all such equipment shall be inspected by the Engineer to verify the Contractor installations meet the standards of the state of good maintenance.

B. Cable ends shall be resealed promptly when a length is cut from the reel. Cable reels shall be properly handled, i.e., by using a sling and spreader attached to a shaft through the reel hubs, or by cradling both flanges between lift truck forks. The reels shall not be lifted by the top reel flange or dropped from any height. Lift truck forks shall not touch cable surfaces on the reel. Reels shall not be laid flat, and shall always be rolled in the direction opposite the cable wind on the reel.

C. Verify that the installation design is correct and adequate for the cables to be installed. Ensure that conduit size, conduit fill, conduit bend radii, manhole and pull box/junction box spacing, manhole and pull box/junction box size, raceways, ducts, and associated hardware are proper for the intended installation.

D. Verify the required cable length for each cable run prior to installation. Referenced drawings may be used for defining locations and estimating cable lengths. However, no existing drawings shall be used to determine final lengths and cuts. Actual lengths shall be determined by making on-site inspections and measurements.

E. Wires and cables shall be continuous without splices between junction boxes, terminals, pull boxes, manholes and hand holes. Cable shall not be bent to a radius less than the greater of 20 times the diameter of the cable or the manufacturers’ recommended minimum bending radius, during installation or as finally installed.

F. Install cable per the Engineer approved installation and cable plan. Provide any installation hardware necessary to route, support, terminate, or protect any cable installation.

G. Notify the Engineer 48 Hours notice prior to installing cables.

H. Installation shall conform to RUS TE&CM Parts 641 and 644, and TIA/EIA 568 and TIA/EIA-569 and to applicable sections of the NEC and the requirements as specified.

I. Where cables leave conduits, the end of the conduit shall be fitted with end bells/bushings to prevent damage to the cable.

J. Provide appropriate special protection for cables in areas where the cables are unavoidably exposed to hazardous conditions such as movement, vibration or sharp corners on equipment.

K. Wires and Cables in Conduit: Crossover of cables shall be avoided when cables are pulled into conduits. Care shall be taken not to have the conductors pulled tight or twisted in conduit fittings or boxes. Pull and install all cables to be installed in a single conduit simultaneously.

L. In order for unshielded twisted-pair cabling infrastructure to deliver high-speed performance, it is manufactured to very tight specifications. Consequently, to
maintain the unshielded twisted-pair cabling system performance proper installation practices shall be followed. At minimum follow the requirements listed below:

1. Do not crush the cable (by over cinching with cable ties or by using a staple gun). Use of Velcro cable ties in the rooms is required.

2. Do not kink, knot or snag the cable while pulling; this will cause damage under the jacket and may alter cable performance.

3. Do not exceed the recommended pulling tension. A break away swivel shall be used for fiber optic cable.

4. Per TIA/EIA 568, do not untwist the pairs of cable beyond the absolute minimum required for termination.

5. The cable jacket on UTP shall only be stripped back the minimum required per TIA/EIA 568 to terminate to connecting hardware.

6. Maximum cable lengths shall not be exceeded. (295 feet for UTP horizontal runs or 328 feet for UTP channel).

7. Properly rated patch cables will be provided and tested, from patch panels to equipment and from port to port for fiber patch panels, to provide continuity from end to end. Channel testing, inclusive of patch cords, will be in accordance with TIA/EIA 568.

8. Per the NEC, a 40 percent fill ratio for all conduit runs is recommended for conduits with more than 2 cables.

9. All fiber optic cables shall be set in inner-duct with an appropriate flame and smoke rating equal or better to the cables being housed.

10. SC type connectors for fiber are recommended by TIA/EIA 568 (orange for multi-mode and yellow for single mode).

M. Use no oil, grease, or similar substances to facilitate the pulling in of conductors. Use a specifically approved wire pulling compound.

N. Pull in no wire or cable until all construction which might damage insulation or fill conduit with foreign material is completed.

O. Pull wire into conduits with care and prevent damage to insulation. Use basket-pulling grips to avoid slipping of insulation on conductors. Nylon, polypropylene or hemp rope, or other “soft” surfaced cable must be used for pulling in conduit other than steel.

P. Do not use blocks, tackle, or other mechanical means to pull wires No. 8 AWG, or smaller.

Q. For wire/cable runs above suspended ceilings, which are not in conduit, clamp cable to underside of deck or use wire hangers; do not allow it to lie on top of
the ceiling panels. In open ceiling areas, clamp cable to underside of deck in pan troughs or along beams to aid concealment.

R. Support wire and cable in all equipment, all terminal cabinets and in all terminals and pull boxes in vertical risers and horizontal runs. Use wire duct and strap-type supports. Furnish and install appropriate wire duct at all locations where wire duct is required for good wire management, whether shown on elevations or not. Where terminal boards are used, furnish and install wire duct on both sides. At no time shall wires cross over terminal boards. Arrange cables neatly to allow inspection, removal, and replacement.

S. Provide grommets and strain relief material where necessary to avoid abrasion of wire and excess tension on wire and cable.

T. Comb wire groups. Route and support wiring and cable to achieve the highest quality appearance in all areas, including the interior of all panels and racks.

U. Make no splices in cables. Cables shall be continuous between all designed termination points.

### 3.02 TERMINATIONS

A. Copper Cable:

1. Cables shall be trained into final position while observing minimum bending radii. Provide slack at all terminals in an amount sufficient for three re-terminations.

2. Wire and cables where connected directly to equipment shall be of sufficient length to allow access for removal and inspection of equipment without having to disconnect. Wires and cables shall be continuous, without splices, between terminals within a housing and enclosure or piece of equipment.

3. Termination work shall be conducted under clean and dry conditions. Connectors shall be fitted with retentive dust caps.

4. For stranded copper wire, compression-type, insulated terminals in accordance with the wire and cable manufacturers' recommendations shall be used. The terminals shall be installed only with tools and techniques recommended by the terminal manufacturer. Solid wire shall be terminated by wire eyes. IDC-type termination blocks will be used only with solid conductors.

5. Wires and cables shall be terminated at protected terminal blocks. Compression-type insulated terminal connections to terminal blocks shall use a single washer on top of the terminal. Wire eyes require two washers for one eye, three washers for two eyes. Connections shall be completed with double nuts torque to the rated value of the nut.

6. All audio cables entering cabinets or facilities shall be protected with protection equipment specifically design for such application.
7. Protected Terminal Blocks shall be DIN rail mounted and grounded to the corresponding facility or cabinet communications ground bus.

B. Fiber:

1. Slack in Fiber Distribution Panel (FDP) shall be restrained and shall be sufficient for strain relief per TIA/EIA 568.

2. Attach the central strength member of cable to the FDP. Attach the outer jacket of the cable to the FDP with a cable clamp.

3. Run fiber optic cable inside buildings in protective inner-duct. Inner-duct shall extend into the FDP for continuous cable protection and identification.

4. Fiber optic splices shall be fusion splices. Fusion splicing shall be performed by qualified personnel utilizing splicing equipment with Local Injection and Detection (LID) to optimize splices. The loss across each spliced fiber shall be less than or equal to 0.04 dB.

3.03 CABLE TIES

A. Sized appropriately and rated to the installation conditions. Plenum rated cable ties will be used where any cable supported is rated CMP.

B. Install at 4-foot maximum intervals, roughly centered between hangers, and at other appropriate locations to keep the wire groups neat. Ensure the cable ties do not cause cables to exceed with the minimum bend radius requirement.

3.04 IDENTIFICATION TAGS FOR CABLES, WIRES AND EQUIPMENT

A. Tag all wires and cables during the termination process, as specified herein. Tagging formats and administrative records shall be maintained for all cables in accordance with TIA/EIA-606. Labels shall be concise and preferably diagrammatic in form.

B. Identify all conductor wires and cables whenever they enter or leave a junction box, manhole, housing, or enclosure, and at all terminals.

C. Securely fasten marking tags to the wires and cables for identification. Place tags prior to termination.

D. Wire designations shall consistently conform to an overall scheme approved by the Engineer to indicate location, circuit, device, wire number, terminal branch, and position, etc. Use letters and numbers.

E. Cables and Wires:

1. A unique identifier shall be assigned to, and marked on each cable to serve as a link to the cable record. Both ends of each cable and each cable wire and all single wires that terminate in equipment cabinets, equipment terminal blocks, punch down blocks and computers shall be permanently identified with a tag. Tags shall not obscure connection
links used between terminal binding posts. Tags shall be installed so that they may be read with a minimum of disturbance of the tags. Tags will be placed not greater than 2 inches from the point of wire or cable termination.

2. Tag Installation: Install tags and apply conductor nomenclature in accordance with the manufacturer's instructions. Installation shall result in a permanently bonded and legible identification.

3. Spare wires for future use shall be labeled, with exposed ends taped.

F. Post cable schedule and identification key on each equipment rack and cabinet door for future reference.

3.05 FIELD QUALITY CONTROL

A. Refer to Section 01545, Work Site Safety and Security, and General Conditions and Special Conditions in regard to safety in proximity to the operating system.

B. Follow approved cable testing plan.

C. Provide all instruments, materials and labor required for tests specified.

D. Notify the Engineer of testing schedule for the purpose of witnessing complete testing on all cable installations.

E. Follow test equipment manufacturer's instructions as to operation and electrical connections.

F. Testing Copper Cables:

1. The test plan shall include the insulation resistance and continuity tests. The test plan will conform to RUS Specification 7 CFR 1755 Bulletin 1753F-201 (PC-4) for multi-pair cable. Category 6 level data cables shall be tested and certified per TIA/EIA 568.

2. All associated communications equipment not under test shall be disconnected and grounded. All electronic devices or signal equipment shall be disconnected or unplugged prior to any testing. All cable splices shall have been completed.

3. After installation of the entire length of a cable, perform the tests listed below on each cable. To preclude damage to equipment and devices, conduct the tests before the cable is terminated at the electrical equipment. If termination has been made, disconnect cables from the equipment for testing and reconnect after completion of tests.

4. Dielectric Test: Perform test to ensure that the cable insulation has not been impaired during installation.

5. Continuity Test: Perform test to prove the continuity of the conductor. The test shall be made of all conductors and shields.
6. Insulation Resistance Test: Perform test to determine the conductor to ground resistance and conductor to conductor resistance. Conduct tests with a 500V motor-driven megger. Apply test voltage between the conductor and ground and hold until the reading reaches a constant value for five minutes. Insulation resistance values obtained by the megger tests shall not be less than two mega-ohms. Bring to the Engineer’s attention the results of similar tests having unequal readings with the variations of 25 percent or more.

7. Perform end-to-end tests on all cables where cables enter or leave cases, communication houses or other facilities.

8. For each test, record all data on approved test forms.

9. Replace with new cable any installed cable found defective during testing.

G. Testing Fiber Cables: Refer to Source Quality Control herein for factory testing. Perform the following installed tests after installation is complete.

1. Notify the Engineer 24 hours in advance of testing.

2. Record optical link attenuation from FDP to FDP. Record optical channel attenuation from FDP to each Distribution inclusive of optical patch cords and connections passing through multiple links (Distribution and patch panels) per TIA/EIA 568-B.3.

3. Submit OTDR records including hardcopy and CD softcopy, for both directions of transmission, to the Engineer.

4. Test all fibers:
   a. OTDR tests shall be performed such that the FDP and patch panel terminations and jumpers shall be shown.
   b. The loss across each connector and splice shall be shown. There shall be no single point loss on a fiber greater than 0.1 dB per TIA/EIA 568.

H. For fiber optic cable, complete on-site baseline OTDR testing and submit test reports prior to cutover.

I. For UTP CAT 6 cable, complete manufacturer recommended testing and submit test reports prior to cutover.

END OF SECTION
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):

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.


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, ¾” 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 pullout 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, conduits 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
PART 1- GENERAL

1.01 DESCRIPTION

A. Section includes requirements for fiber optic cable and associated passive components to provide a complete fiber optic structured cable system for station communications.

B. Active components such as media converters and network switches are specified in Sections related to individual station communications subsystems.

1.02 REFERENCE STANDARDS

A. American National Standards Institute (ANSI):
   1. ICEA S-87-640 Fiber Optic Outside Plant Communications Cable
   2. TIA-455-177, FOTP-177 Optical Fibers Part 1-43: Measurement Methods and Test Procedures - Numerical Aperture

B. ASTM International (ASTM):
   1. D1248 Specification for Polyethylene Plastic Extrusion Material for Wire and Cable
   2. E814 Test Method for Fire Test of Through - Penetration Fire Stop

   1. 7CFR1755.900 RUS Specification for Filled Fiber Optic Cables

D. Telecommunications Industry Association (TIA)/ Electronics Industries Alliance (EIA):
   1. TIA/EIA 455 Standard Test Procedure for Fiber Optic Fiber Cables, Transducers, Sensors. Connecting and Terminating Devices and Other Fiber Optic Components
   2. TIA/EIA 455-3, FOTP-3 Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components
   3. TIA 455-13, FOTP-13 Visual and Mechanical Inspection of Fiber Optic Components, Devices, and Assemblies
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23. TIA 568.3  Commercial Building Telecommunications Cabling Standard, components of fiber optic cable systems.

24. TIA-598  Optical Fiber Cable Color Coding

25. TIA/EIA-606  Administration Standard for Telecommunications Infrastructure

1.03 DESIGN CONSIDERATIONS

A. Station Communications shall deploy a fiber optic cable distribution as follows:

1. Single-mode fiber optic cable shall be deployed where subsystem products are available. Single-mode fiber optic cable shall be deployed on the station facility and platform grounds inside CER cabinets and between CER and the DC. Single mode fiber optic cable shall also be deployed between stations CER’s and between station CER’s and wayside systems not located on station or platform grounds.

2. Fiber optic cable shall serve as the backbone medium between the station communications equipment room (CER) and communication distribution cabinet (DC). The fiber cable shall be placed in a physical ring backbone topology. Backbone fiber cables shall consist of 24-strand single-mode fiber cabling, which shall be of outside plant design for outdoor applications and plenum design for indoor applications. All fibers shall be terminated, tested and certified, whether working or spare (dark).

3. There will be no intermediate cross-connect, patching, consolidation point, or other termination of the fiber optic cable between the CER and the DC.

4. The fiber optic backbone will be configured in a physical ring topology. The CER and each field communications distribution cabinet will have physically redundant entrances to facilitate the ring topology.

5. To facilitate future integrated (fiber direct) subsystem devices, single-mode fiber optic backbone cable will be deployed. The minimum cable size will be 24-strand cable.

6. Upon receiving the fiber cable shipment reels at the site, the Contractor shall conduct all necessary testing to verify and demonstrate to the Engineer that the shipped fiber cables are acceptable. All deficient or rejected fiber cabling equipment shall be rejected and returned back to the vendor for substitution.

7. Use of Multi-mode fiber cable and the associated equipment solutions shall be avoided and could only be permitted as an exception (due to
lack of adequate substitute based on single-mode fiber solution) and only if approved by the Engineer.

1.04 SUBMITTALS

A. Refer to Section 17000, Basic Communications Technical Requirements, for related and additional submittal requirements.

B. Submittals shall consist of a complete design description, including detailed drawings, specifications, and submittals of all subsystems and elements within the subsystem. Each calculation, test procedure, final drawing and submittal shall be reviewed and signed by a BICSI Registered Communications Distribution Designer (RCDD). For submittals involving engineering design services required by governing codes and regulations; system design and design calculations shall be sealed and signed in blue ink by a professional engineer, currently registered in the State of California, for the discipline involved. The final design document shall contain sufficient details for construction.

C. Submittals shall include all materials, equipment, assembly and installation required to carry out the functions and purposes indicated in the Specifications, and to make the system suitable for the purpose for which it is intended, whether or not such materials, equipment, assembly and installation are specially indicated in the requirements of the Specifications.

D. Design submittal shall define interfaces between the systems. This includes both Communications and Signals.

E. Submit equipment lists including a table or list of model and part numbers for all proposed equipment and materials to be used for individual subsystems. Include the expected lead-time for each item while identifying in boldface type the ones with greater than 30 days. Group table or list for each subsystem with functional descriptions of equipment or material included.

1. Quantities by individual work location shall be included.

F. Submit Product Data Sheets with product information in sufficient detail to indicate that components meet these Specifications. The product model shall be indicated explicitly with arrow or underline on the product sheet submitted.

G. Submit calculations for each fiber optic cable span showing link margin and system gain.

H. Schedule: Submit schedule including identification and description of all major system cutover events or integration activities describing techniques, methods, duration and procedures.

I. Submit electrical, mechanical, and network communications block and functional diagrams with corresponding parts list using current AutoCAD standards.

J. Submit cable running lists per subsystem. Lists shall identify the size and type of cable, and identify the termination points of both cable ends. Include cable termination assignments by fiber strand or copper wire. Specify cable labeling (tags) for each cable per end.
K. Submit drawings showing equipment placement within the station. Include floor or wall profiles showing the location of equipment cabinets. Include vertical cabinet profiles showing the assigned placement of equipment within the cabinet. Depict all equipment within a cabinet, whether said equipment is new or existing.

L. Manufacturer Qualifications: Submit manufacturer’s qualifications. Include cable manufacturer’s ISO 9001 Certification Number.

1.05 QUALITY ASSURANCE

A. Materials, design, installation, and testing shall comply with all applicable Standards included herein. Be familiar with and adhere to the latest editions of these codes, regulations, specifications and standards.

B. Work shall meet or exceed the standards and procedures specified.

C. In the event of conflicts between reference standards, the most stringent provisions shall apply to the Work of this Section.

D. Manufacturer Pre-Qualification Requirements:

1. Obtain Engineer’s approval of cable manufacturers and installers. The Provide all data required for Engineer evaluation and shall make the arrangements for any required demonstrations and tests.

2. Qualifications shall be based on the following criteria:

   a. Past Performance and Experience: The cable manufacturers shall demonstrate previous successful experience in supplying, testing and installation of fiber optic cable specified herein.

   b. Quality Assurance Program

      i. The manufacturer of cables, in accordance with the requirements of these technical specifications, shall have in place or implement, an effective quality assurance program adhering to the requirements of ISO 9001 to ensure purchase control performance.

      ii. The cable manufacturer shall be ISO 9001 certified.

   c. Warranty

      i. The manufacturer shall warrant that the design, material, and workmanship incorporated in each item of cable shall be of the highest grade and consistent with the established, and generally accepted standards for fiber optic cable for transit applications; and that each such item and every part and component thereof shall comply with the Specifications.
ii. The Contractor shall monitor the manufacturers of the cable to assure that the Engineer approved Quality Assurance Program is being closely adhered to and that the fiber optic cable is being manufactured in accordance with these specifications.

iii. If the cable supplier is not the manufacturer of the fiber, the fiber manufacturer shall be identified.

1.06 DELIVERY, HANDLING, AND STORAGE

A. Packing: Ship cable on non-returnable wooden reels. The diameter of the drum shall be at least 20 times the diameter of the cable. Ship cable shall be shipped on reels substantial to withstand reasonable handling and shall be so designed that the inner end of the cable be accessible, but protected from injury. All ends of the cable shall be sealed to prevent entrance of moisture and securely fastened to prevent them from becoming loose during transit.

B. Marking: Label each reel on the outside flange with the following information:

1. Manufacturer's name
2. Contract name and number
3. Cable identification number
4. Cable length
5. Date of manufacture
6. Copy of the factory test results

PART 2- PRODUCTS

2.01 FIBER OPTIC CABLE

A. General Fiber Optic Cable Specifications:

1. All fibers in the cable shall be usable and meet required specifications.

2. The life expectancy of the cable shall be 25 years for service in a railroad and transit environment.

3. The cable shall be designed for installation in underground conduit, wet or dry environments, including alternating wet and dry conditions.

4. All fiber optic cable run in conduits or duct banks shall be an accepted product of the USDA Rural Utilities Service (RUS) 7 CFR 1755.900 and meet the requirements of ICEA S-87-640.

5. Each optical fiber shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.
6. Each optical fiber shall consist of a germanium-doped silica core surrounded by a concentric glass cladding. The fiber shall be a matched clad design.

7. Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi (0.7 GN/m2).

8. The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.

9. The attenuation specification shall be a maximum value for each cabled fiber at 23 ± 5 °C on the original shipping reel.

B. Enhanced Single-mode Optical Fiber for Telecommunications Applications:


2. Geometry Standards:
   a. Cladding Diameter (μm) = 125.0 ± 0.7
   b. Core-to-Cladding Concentricity (μm) ≤ 0.5
   c. Cladding Non-Circularity ≤ 0.7 %
   d. Mode Field Diameter @ 1550 nm (μm) = 10.3 ± 0.5
   e. Effective Area, Aeff (Characterized): (μm²) = 72
   f. Coating Diameter (μm) = 245 ± 5
   g. Colored Fiber Nominal Diameter (μm) = 242 ± 7
   h. Fiber Curl radius of curvature (m) > 4.0 m

3. Optical Standards:
   a. Cabled Fiber Attenuation @ 1310 nm (dB/km) ≤ 0.35
   b. Cabled Fiber Attenuation @ 1550 nm (dB/km) ≤ 0.25
   c. Point discontinuity @ 1550 nm (dB) ≤ 0.25
   d. Cable Cutoff Wavelength (λccf) (nm) ≤ 1480
   e. Total Dispersion (ps/(nm•km))
      1300 nm = ≤ 3.0
      1530 - 1565 nm = ≤ 18.0
f. Cabled Polarization Mode Dispersion (ps/km) \(\leq 0.1\) max

g. Water Peak Attenuation @1383±3 nm; \(\leq 2.1\) dB/km

4. Environmental and Mechanical Specifications:

a. Temperature Cycling -60°C to +85°C

b. Temperature-Humidity Cycling -10°C to +75°C, 98 % RH

c. Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi (0.7 GN/m²).

d. The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.

e. Crush Resistance = 10 kN/m (685 lb/ft) length of cable.

f. Cable Outside Diameter equal or < 0.65 inch

g. Weight per 1000 linear foot equal or <160lbs

h. Minimum Bending Radius:

Installation, 15X Diameter
Static, 12X Diameter

5. Cable Construction (Jacketed and Armored, Duct or Burial):

a. The cable meets the specifications set forth in Bellcore GR-20-CORE. Cable is listed by RUS to ICEA S-87-640 – ISO 9001 – 14001 – TL 9000 and shall be approved for use by RUS.

b. Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be either 2.5 mm or 3.0 mm. Each buffer tube shall contain up to 12 fibers. The fibers shall not adhere to the inside of the buffer tube. The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrink-back requirements of USDA RUS 7 CFR 1755.900.

c. Each fiber shall be distinguishable by means of color coding in accordance with TIA-598. The fibers shall be colored with ultraviolet (UV) curable inks. Buffer tubes containing fibers shall be color coded with distinct and recognizable colors in accordance with TIA-598. Buffer tube colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be 1.0 mm. In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and not subject to
fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.

d. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed. Fillers shall be placed so that they do not interrupt the consecutive positioning of the buffer tubes. In dual layer cables, any filler shall be placed in the inner layer. Fillers shall be nominally 2.5 mm or 3.0 mm in outer diameter.

e. The central member shall consist of a dielectric, glass reinforced plastic (GRP) rod. The purpose of the central member is to provide tensile strength and prevent buckling. The central member shall be over coated with a thermoplastic when required to achieve dimensional sizing to accommodate buffer tubes/fillers.

f. Each buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional nontoxic solvents.

g. Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation, or "S-Z", stranding process. Water wellable yarn(s) shall be applied longitudinally along the central member during stranding.

h. Two polyester yarn binders shall be applied contra-helically with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking, and dielectric with low shrinkage.

i. For single layer cables, a water swellable tape shall be applied longitudinally around the outside of the stranded tubes/fillers. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter. For dual layer cables, a second (outer) layer of buffer tubes shall be stranded over the original core to form a two layer core. A water swellable tape shall be applied longitudinally over both the inner and outer layer. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter.

j. Cables shall contain two ripcords under the steel armor for easy armor removal. Additionally, armored cables that have an inner sheath shall also contain one ripcord under the inner sheath.

k. Tensile strength shall be provided by the central member, and additional dielectric yams as required. The dielectric yams shall be helically stranded evenly around the cable core.
Cables shall have an inner sheath of Medium Density Polyethylene (MDPE). The minimum nominal jacket thickness of the inner sheath shall be 1.0 mm. The inner jacket shall be applied directly over the tensile strength members (as required) and water swellable tape. A water swellable tape shall be applied longitudinally around the outside of the inner jacket.

The armor shall be a corrugated steel tape, plastic-coated on both sides for corrosion resistance, and shall be applied around the outside of the water blocking tape with an overlapping seam with the corrugations in register. The outer jacket shall be applied over the corrugated steel tape armor. The outer jacket shall be a MDPE with a minimum nominal jacket thickness of 1.4 mm. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

The MDPE jacket material shall be as defined by ASTM D1248, Type II, Class C, Category 4 and Grades J4, E7 and E8. The jacket or sheath shall be free of holes, splits, and blisters. The cable jacket shall contain no metal elements and shall be of a consistent thickness.

The outer surface of the jacket of each shipping length of cable shall be permanently identified by printing (in a contrasting color) descriptive information on the outer surface of the jacket at intervals of 1500 mm (5 feet) or less. The information shall include identification (Caltrain Communications System), count of fibers, fiber type, date of manufacturing (month and year), manufacturer's part number, manufacturer's name, sequential meter or foot markings, a telecommunication handset symbol as required by Section 350G of the National Electrical Safety Code (NESC), fiber count, and fiber type. The actual length of the cable shall be within -0/+1 percent of the length markings. The print color shall be white, with the exception that cable jackets containing one or more co-extruded white stripes, which shall be printed in light blue. The height of the marking shall be approximately 2.5mm.

If the initial marking fails to meet the specified requirements, i.e., improper text statement, color, legibility, or print interval, the cable may be remarked using a contrasting alternate color. The numbering sequence shall differ from the previous numbering sequence, and a tag shall be attached to both the outside end of the cable and to the reel to indicate the sequence of remarking. The preferred remarking color shall be yellow, with the secondary choice being blue.

C. Multi-mode Fiber for Local Area Network (LAN) Applications:

1. Multimode fibers shall meet EIA/TIA-492AAAA- "Detail Specification for 62.5-\(\mu\)m Core Diameter/125-\(\mu\)m Cladding Diameter Class 1a Graded-
Index Multimode Optical Fibers." These fibers shall have the same specified performance and geometry values as noted below:

2. All fibers in the cable shall be usable and meet required specifications.

3. Each optical fiber shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.

4. Each optical fiber shall consist of a germanium-doped silica core surrounded by a concentric glass cladding. The fiber shall be a matched clad design.

5. The attenuation specification shall be a maximum value for each cabled fiber at 23 ± 5 degrees C on the original shipping reel.

6. Geometry:
   a. Core Diameter 62.5 ± 3.0um
   b. Core Non-Circularity ≤ 5 percent
   c. Cladding Diameter 125.0 ± 2.0um
   d. Cladding Non-Circularity < 2.0 percent
   e. Core-to-Cladding Concentricity ≤ 3.0um
   f. Coating Diameter 245 ± 5um
   g. Colored Fiber Nominal Diameter 253 – 259um

7. Optical:
   a. Cabled Fiber Attenuation
      i. 850 nm < 1.0 dB/km
      ii. 1300 nm ≤ 3.5 dB/km
   b. Point discontinuity
      i. 850 nm < 0.2 dB
      ii. 1300 nm ≤ 0.2 dB
   c. Macrobend Attenuation
      i. Turns: 100; Mandrel OD - 75 ± 2 mm, < 0.5 dB at 850 nm
      ii. Turns: 100; Mandrel OD - 75 ± 2 mm, < 0.5 dB at 1300 nm
d. Cabled Effective Bandwidth Modal
   850 nm, > 385 MHz/km

8. IEEE 802.3 GbE Distance
   a. 1000BASE-SX Window (850 nm), up to 500m
   b. 1000BASE-LX Window (1300 nm), up to 1000m

9. OFL Bandwidth
   a. 850 nm, > 200 MHz/km
   b. 1300 nm, > 500 MHz/km

10. Numerical Aperture 0.275 ± 0.015

11. Mechanical Specifications:
   a. Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi (0.7 GN/m²).
   b. The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.
   c. Crush Resistance = 10 kN/m (685 lb/ft) length of cable.
   d. Cable Outside Diameter < 0.65 inch
   e. Weight per 1000 linear foot < 160lbs
   f. Minimum Bending Radius
      i. Installation, 15X Diameter
      ii. Static, 12X Diameter
   g. Temperature (Operational)
      i. -30 degrees C (-22 degrees F) to +60 degrees C (140 degrees
      ii. Continuous operation at -30 degrees C (-22 degrees F) without cracking or becoming brittle
   h. Temperature (Storage)
      i. -40 degrees F to +158 degrees F on reel
      ii. Humidity @ 0 to 100 percent, inclusive
j. Tensile Strength  
   i. Installation @ 2,700 N (600 lbf)  
   ii. Static @ 890 N (200 lbf)  

D. Single-mode station distribution fiber optic cable will be Superior Essex #110243T01 or Engineer approved equal.  

E. Multi-mode station distribution fiber optic cable will be Superior Essex #130246G01 or Engineer approved equal.  

2.02 FIBER CONNECTORS AND PASSIVE COMPONENTS  

A. Fiber Connectors:  
   1. FDP connectors shall be SC and LC connector type (as required). SC-type connectors shall be the preferred connector for all terminations and equipment interfaces. LC connectors are typically used by the fiber optic connections to the modern Ethernet switches.  
   2. When available network products use connectors other than SC-type, optical patch cables shall be provided with the corresponding non-SC-type connector on the equipment end, and the SC-type connector on the distribution panel end. Example: SC-to-ST patch cord.  
   3. Optical parameters of the connectors shall meet the requirements of EIA/TIA-568.  
   4. SC-type fiber single-mode connectors shall be Hubbell FCSCSQ or approved Equal. SC-type and LC-type fiber connectors and ports for single-mode will be colored yellow. If multi-mode equipment is used, SC-type and LC-type fiber connectors and ports for multi-mode shall be colored orange. Where used, LC-type Single mode connectors shall be Hubbell #FCLCSM or Engineer approved equal.  
   5. Where used, SC-type fiber Multi-mode connectors shall be Hubbell #FCSCMQ or approved Equal. Where used, LC-type fiber Multi-mode connectors shall be Hubbell #FCLCMM or Engineer approved equal.  

B. Fiber Slack Enclosures:  
   1. Enclosures shall be NEMA-12 type with hinged cover and securing mechanism.  
   2. Enclosures shall be sized for 100 feet of cable slack.  
   3. Hardware  
      a. Hooks shall be provided to hold cable slack, with coils of required bend radius.  
      b. Velcro ties to restrain cable shall be utilized.
C. Fiber Distribution Enclosure:

1. Enclosure
   
a. The enclosure shall house the splice shelf and connector sleeve panels for all optical connections but as a minimum shall provide 48 connections for Single Mode and 48 connections for Multi-mode fibers.

b. All OSP cable jackets and central strength members shall be secured to relieve strain.

c. The enclosure shall be mountable in a standard 19” rack and be no more than 3 rack units high.

2. Fiber enclosure will be Hubbell #FCR350SE or Engineer approved equal.

D. Fiber Distribution Panels:

1. Distribution panels shall be a complete system of components by a single manufacturer.

2. Rack mountable connector housings shall be available for cross-connecting or inter-connecting purposes. The units shall provide for direct connecting and pigtail splicing.

3. Housings shall be mountable in an EIA-310 compatible 18.3 inch rack (19 inch EIA). The unit shall meet the design requirements of TIA-568.

4. Molded plastic parts shall meet flammability requirements of UL 94 V-0.

5. The connector housings shall have a labeling scheme that complies with TIA/EIA-606. The housing shall incorporate labeling via an adhesive backed label and a retractable sliding label panel that pulls out from the bottom front of the housing.

6. Housings shall be manufactured using 16-gauge aluminum and shall be finished with a Two-Tone Gunmetal Grey and/or anodized silver for durability. Installation fasteners shall be included and shall be black in color.

7. The unit shall be capable of connectorization and jumper management. The unit shall be capable of splicing or combination connectorization/splicing with the use of an additional splice tray kit.

8. Fiber Cable Routing: The Unit shall have a fiber routing guide platform located in the rear of the housing. The fiber routing guide platform shall be removable using two plunger style latches so that room can be made for an optional splice tray kit.

9. Jumper Routing:
a. The unit shall have a hinged top jumper management panel capable of locking in the horizontal or vertical position. When the top panel is locked in the horizontal position, it shall act as a jumper routing area in the top front of the housing and shall enclose the top of the housing.

b. When the hinged panel of the unit is locked in the vertical position it shall serve as a horizontal jumper management panel capable of routing jumpers out of the top of the housing. Total height of the housing shall be 5U or less.

10. Fan-Out Devices:

a. Provisions for mounting up to 12 fiber fan-out devices shall be incorporated into the housing via a removable slack storage platform in the rear of the housing.

b. Splice capacity shall be 12 splice trays.

11. Units shall include a clamshell-type cable clamping mechanism to provide cable strain relief. The cable clamp shall accept one cable from 0.37 inches-1.12 inches in diameter. The cable clamp mechanism shall also handle multiple smaller fiber count cables when used with a multiple cable insert. The total cable capacity per clamp shall be five cables (0.4 inches) OD when used with the multiple cable insert. Housing cable clamp capacity shall be two clamps. Additional cable clamps shall be available as an accessory kit.

12. The housing shall have four grommet openings for cable entry in the rear of the housing. The unit shall have two removable panels on both the left and right rear of the housing if more than four cable entries are required.

13. Front and rear doors of the connector housings shall be hinged and removable for ease of cable installation.

14. Access Doors:

a. The front doors shall be made from tinted polycarbonate.

b. Front and rear doors shall utilize a single slide latch to provide ready access and closing. An opening shall be provided in the front and rear doors so that an optional key lock kit may be used. The opening shall be filled with a removable plastic insert so that dust may not enter if the optional lock kit is not used. There shall be a removable retaining bracket to prevent the door from being unintentionally slid off the hinges.

15. The housing shall accommodate the future installation of LC, SC, ST, FC, D4, or MTRJ, type connector modules. Each module shall provide twelve connector sleeves.
16. The FDP will be Hubbell #FCRS25SPR or Engineer approved equal. FDP adapter panel with 6 SC-type (or LC-type, if required) fiber bulkhead connectors will be Hubbell #FSPSC6 (or FSPLC6, if required) or Engineer approved equal. Adapter panels used for single-mode fiber will have yellow SC-type (or LC-type, if required) bulkhead ports. Adapter panels used for multi-mode fiber will have orange SC-type (or LC-type, if required) bulkhead ports.

E. Splice Shelf:
1. The splice shelf shall accept slide in/out splice trays for a maximum number of connectors and for the fiber types to be installed.
2. Each splice tray shall restrain and protect fusion or mechanical splices.
3. The splice tray shall hold 12 fusion splices and will be Hubbell #STRAY12F or Engineer approved equal.

F. Connector Sleeve:
1. Connector sleeves shall be the SC-type (or LC type, if required). The connector sleeve shall meet TIA-568-B.3 requirements when connecting mated pairs.
2. The FDP shall be fully populated with connector sleeves.
3. Dust Caps shall be provided for all sleeves.
4. Loss across connection shall not exceed the following, with optical attenuators removed:
   a. Single Mode: 0.5 db
   b. Multi-Mode: 0.5 db
5. The FDP sleeves shall be capable of accepting optical attenuators as required for maintaining the Optical Loss budget.

G. Slack Retention:
1. Slack in pigtails and patch cords shall be neatly coiled and retained such that the minimum-bending radius shall not be exceeded.
2. Slack shall be sufficient for accessing splice shelves and connectors.

2.03 OPTICAL FIBER PATCH CORDS AND PIGTAILS

A. Patch cords and pigtails shall be cable assemblies consisting of flexible optical fiber cable with SC (or LC, if required) compatible connectors. Patch cords shall be complete factory fabricated assemblies from manufacturer’s standard product lines. Fiber optic jumper cables shall meet the following requirements.
B. Patch Cord Assemblies:

1. The cable construction shall allow a small bend radius for installation in space-constrained areas. The cable shall contain a dielectric strength member and a protective outer jacket.

2. The Patch Cord shall comply with the requirements of TIA-568-B.3.

C. Connectors:

1. One SC-type (or LC-type, if required) duplex connector shall be provided on Patch cords.

2. One SC-type (or LC-type, if required) simplex connector shall be provided on pigtails, with the other end prepared for splicing.

3. SC-type (or LC-type, if required) connectors used for single-mode fiber will be colored yellow. SC-type (or LC-type, if required) connectors used for multi-mode fiber will be colored orange.

D. Fiber Cable:

1. Patch cords and pigtails shall utilize a two-fiber zip-cord type jacketed cable, in lengths required to meet minimum bend radius while connected and routed through cable management hardware but no less than 6 feet in length. The cable jacket color shall be orange for multi-mode and yellow for single mode cable. The fiber core size shall also be identified on the outer jacket.

2. The optical fiber shall meet the same characteristic requirements of the distribution panel terminated cable to which it mates.

3. Tensile strength of the jacketed cable shall be greater than or equal to 20 lbs.

E. Single-mode pigtails with SC-type (or LC-type, if required) connector on one end and the other end bare fiber, 3 meters length, shall be Hubbell #FPSCS3SM (or Hubbell #FPLCC3SM, if required) or approved equal. Where used, multi-mode pigtails with SC-type (or LC-type, if required) connector shall be Hubbell #FPSCS3MM (or Hubbell #FPLCS3MM, if required) or Engineer approved equal.

2.04 INNERDUCT

A. Constructed of flame retardant PVC or FCP material and shall meet the following flammability requirements:

1. OSP, inside building horizontal (no more than 50 feet from the point of entrance), and inside building riser inner-duct shall meet the UL 2024 (raceways) flame test.

2. Inner-duct installed in any air plenum environment shall meet NFPA 262-2002.
B. Inner-duct shall have smooth exterior and interior wall, and semi-rigid construction.

C. Inside building horizontal and riser inner ducts shall be flexible and corrugated type.

D. Compatible with the fiber optic cable installed within.

E. Inner diameter shall be 1 inch minimum.

F. Couplers, if used, shall not reduce the inside diameter of the inner-duct.

G. All unused inner-duct shall be preinstalled with lubricated pull tape or line.

H. Inner-duct used to house single-mode fiber cable will be colored yellow. Inner-duct used to house multi-mode fiber cable will be colored orange.

2.05 WIRE PULLING LUBRICANT

A. Wire Pulling Lubricant shall have the following characteristics:

1. Polymer-based

2. Average Coefficient of Friction: $\leq 0.055$

3. Temperature Range: -28 degrees F -180 degrees F

4. Compatible with all cable types

2.06 AIR BLOWN FIBER OPTIC SYSTEMS

A. General Fiber Specifications:

1. All fibers in the bundle must be usable and meet required specifications.

2. Each optical fiber shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.

3. Each optical fiber shall consist of high-grade silica, doped as necessary to achieve the required light guiding properties. The fiber shall be a matched clad, step-index design.

4. The fiber shall be coated with a dual layer of ultra-violet cured acrylate resin protective coating. The coating shall be in physical contact with the cladding surface.

5. The attenuation specification shall be a maximum value for each bundled fiber at 23 ± 5 °C on the original shipping reel.

6. The fibers will be contained in a soft inner acrylate layer, an outer harder layer which protects the fibers from damage, and a low friction layer that assists in improved blowing distance, typically in excess of 1000 meters.
7. Fiber bundle units will be available in a range of lengths up to 6000 meters.

B. The main optical, geometrical, and physical characteristics will be compliant with ITU-T Rec. G.652 C/D for Low Water-peak Single-mode Fiber.

1. Geometry Standards:
   a. Cladding Diameter (μm) = 125.0 ± 0.7
   b. Core Concentricity (μm) ≤ 0.84
   c. Cladding Non-Circularity ≤ 1.0 %
   d. Mode Field Diameter @ 1310 nm (μm) = 8.8 – 9.6
   e. Effective Area, Aeff (Characterized): (μm²) = 72
   f. Coating Concentricity (μm) ≤ 12.0

2. Optical Standards:
   a. Cabled Fiber Attenuation @ 1310 nm (dB/km) ≤ 0.38
   b. Cabled Fiber Attenuation @ 1550 nm (dB/km) ≤ 0.26
   c. Point discontinuity @ 1550 nm (dB) ≤ 0.1
   d. Attenuation at 1383 nm (dB/km) ≤ 0.35
   e. Attenuation Uniformity over 2km (dB/km) ≤ 0.05
   f. Dispersion Slope @ ps/(nm².km) ≤ 0.089
   g. Cable Cutoff Wavelength (λccf) (nm) ≤ 1480
   h. Total Dispersion (ps/(nm•km))
      1285 - 1330 nm ≤ 3.5
      1550 nm ≤ 18.0
   i. Cabled Polarization Mode Dispersion (ps/km) ≤ 0.5
   j. Water Peak Attenuation @ 1383+/– 3 nm; ≤ 2.1 dB/km

C. Environmental and Mechanical Tests and Specifications:

1. Operation / Storage -10°C to +60°C yields ≤ 0.07 db/km @ 1310 and 1550 nm.
2. Condensation tested -10°C to +65°C @ 93% RH for 24 hours x 10 yields ≤ 0.07 db/km @ 1310 and 1550 nm.
3. Water immersion test at +20°C for 2000 hours yields ≤ 0.07 db/km @ 1310 and 1550 nm.

4. Cold tested at -20°C for 96 hours yields ≤ 0.07 db/km @ 1310 and 1550 nm.

5. Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi (0.7 GN/m2).

6. Bend tested @ 40 mm (2 & 4 fibers) or 60 mm (8 fibers) yields no change in attenuation after test.

7. Aged Bend tested (60°C for 1000 hours) 40 mm (2 & 4 fibers) or 60 mm (8 fibers) yields no change in attenuation after test.

8. Tensile Strength tested @ 1W N (9.81x mass of 1km) ≤ 0.4% (max fiber strain)

9. 12 Fiber Outside Diameter ≤ 1.3 mm

10. 12 Fiber Weight ≤ 1.5 g/m

11. 12 Fiber Blowing Distance 1000m typical

12. 12 Fiber Breakout 8 minutes typical

2.07 TECHNICAL SPECIFICATIONS FOR AIR BLOWN FIBER DUCT

A. Air blown fiber tube installed in existing duct, conduit, or inside buildings will meet the following criteria:

1. Tubes will be low friction HDPE in small diameters for air blown fiber tubes up to 12 fibers per tube.

2. Each 12-fiber primary tube will have an outside diameter (O/D) of 5 mm.

B. A secondary HDPE fiber duct will house multiple primary 5 mm fiber tubes with the following specifications:

<table>
<thead>
<tr>
<th>Fiber Capacity</th>
<th>O.D (mm)</th>
<th>Nominal Weight (g/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 x 5mm tubes (24 fibers)</td>
<td>12.8-13.8</td>
<td>78</td>
</tr>
<tr>
<td>4 x 5mm tubes (48 fibers)</td>
<td>14.8-16.5</td>
<td>116</td>
</tr>
<tr>
<td>7 x 5mm tubes (84 fibers)</td>
<td>17.8-19.4</td>
<td>159</td>
</tr>
<tr>
<td>12x5mm tubes (144 fibers)</td>
<td>23.0-24.8</td>
<td>234</td>
</tr>
<tr>
<td>24x5mm tubes (288 fibers)</td>
<td>32.3-34.4</td>
<td>422</td>
</tr>
</tbody>
</table>

C. The secondary multi-tube duct will include a moisture barrier aluminum shield and outer polyethylene sheath. A ripcord will be included for easy cable access. The following shall apply to all secondary multi-tube assemblies:
1. Maximum tensile strength (N) = 1W; tested in accordance with IEC 60794-1-2 Method E1. There will be no permanent deformation of the primary or secondary assemblies after an applied load of 1.0 (spec.weight kg/km) N at 20 mm/minute.

2. The Crush Rating (KN) = 1; tested in accordance with IEC 60794-1-2 Method E3. There will be no permanent deformation of the primary assemblies greater than 0.5 mm after a maintained load of 1KN for 1 minute.

3. The minimum bend radius (mm) = 12 x diameter

4. Stress crack resistance will be tested in accordance with BS6469 Section 99.1 with chemical Caflon CF30.

5. Individual fiber tubes will be opaque or translucent for fiber visibility.

6. Secondary multi-tube duct will be available on drums up to 3000m in length.

D. Air blown fiber tube installed outside, direct bury, will meet the following criteria:

1. Tubes will be low friction HDPE in small diameters for air blown primary fiber tubes up to 12 fibers per tube.

2. Each 12-fiber primary tube will have an outside diameter (O/D) of 5 mm.

E. A secondary HDPE fiber duct will house multiple primary 5 mm fiber tubes with the following specifications:

<table>
<thead>
<tr>
<th>Fiber Capacity</th>
<th>O.D (mm)</th>
<th>Nominal Weight (g/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 x 5mm tubes (24 fibers)</td>
<td>11.0-13.2</td>
<td>142</td>
</tr>
<tr>
<td>4 x 5mm tubes (48 fibers)</td>
<td>18.1-22.3</td>
<td>204</td>
</tr>
<tr>
<td>7 x 5mm tubes (84 fibers)</td>
<td>21.6-23.3</td>
<td>278</td>
</tr>
<tr>
<td>12x5mm tubes (144 fibers)</td>
<td>28.2-29.5</td>
<td>479</td>
</tr>
<tr>
<td>24x5mm tubes (288 fibers)</td>
<td>37.8-39.1</td>
<td>755</td>
</tr>
</tbody>
</table>

F. The secondary multi-tube duct will include a moisture barrier aluminum shield and two (2) heavy duty outer polyethylene sheath layers. A ripcord will be included for easy cable access. The following shall apply to all secondary multi-tube assemblies:

1. Maximum tensile strength (N) = 1W; tested in accordance with IEC 60794-1-2 Method E1. There will be no permanent deformation of the primary or secondary assemblies after an applied load of 1.0 (spec.weight kg/km) N at 20 mm/minute.

2. The Crush Rating (KN) = 2; tested in accordance with IEC 60794-1-2 Method E3. There will be no permanent deformation of the primary assemblies...
assemblies greater than 0.5 mm after a maintained load of 2 KN for 1 minute.

3. The minimum bend radius (mm) = 12 x diameter.

4. Stress crack resistance will be tested in accordance with BS6469 Section 99.1 with chemical Caflon CF30.

5. Individual fiber tubes will be opaque or translucent for fiber visibility.

6. Secondary multi-tube duct will be available on drums up to 3000 m in length.

G. Air blown fiber tube installed outside, direct bury, armored, will meet the following criteria:

1. Tubes will be low friction HDPE in small diameters for air blown primary fiber tubes up to 12 fibers per tube.

2. Each 12-fiber primary tube will have an outside diameter (O/D) of 5 mm.

3. A secondary HDPE fiber duct will house multiple primary 5 mm fiber tubes with the following specifications:

<table>
<thead>
<tr>
<th>Fiber Capacity</th>
<th>O.D (mm)</th>
<th>Nominal Wt (g/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 x 5mm tubes (24 fibers)</td>
<td>11.9</td>
<td>353</td>
</tr>
<tr>
<td>4 x 5mm tubes (48 fibers)</td>
<td>18.9</td>
<td>536</td>
</tr>
<tr>
<td>7 x 5mm tubes (84 fibers)</td>
<td>21.9</td>
<td>630</td>
</tr>
<tr>
<td>12x5mm tubes (144 fibers)</td>
<td>27.1</td>
<td>756</td>
</tr>
<tr>
<td>24x5mm tubes (288 fibers)</td>
<td>36.5</td>
<td>1071</td>
</tr>
</tbody>
</table>

H. The secondary multi-tube duct will include an inner polyethylene sheath layer, a corrugated armored layer, and an outer heavy duty polyethylene sheath layer. A ripcord will be included for easy cable access. The following shall apply to all secondary multi-tube assemblies:

1. Maximum tensile strength (N) = 1W; tested in accordance with IEC 60794-1-2 Method E1. There will be no permanent deformation of the primary or secondary assemblies after an applied load of 1.0 (spec.weight kg/km) N at 20 mm/minute.

2. The Crush Rating (KN) = 2; tested in accordance with IEC 60794-1-2 Method E3. There will be no permanent deformation of the primary assemblies greater than 0.5 mm after a maintained load of 3KN for 1 minute.

3. The minimum bend radius (mm) = 12 x diameter.
4. Stress crack resistance will be tested in accordance with BS6469 Section 99.1 with chemical Caflon CF30.

5. Individual fiber tubes will be opaque or translucent for fiber visibility.

6. Secondary multi-tube duct will be available on drums up to 3000m in length.

2.08 SOURCE QUALITY CONTROL - CABLE FACTORY TESTING

A. Factory tests shall be performed in accordance with TIA/EIA -455.

B. Cable shall be tested on-reel prior to shipment.

C. End to end loss shall be recorded for each fiber at 1,310 nm, 1,550 nm and 1,625 nm (for Single-mode).

D. End to end loss shall be recorded for each multi-mode fiber at 850 nm, and 1,300 nm.

E. OTDR with hardcopy record shall be provided for each single mode fiber, at 1,300 nm, 1,550 and 1,625 nm.

F. OTDR with hardcopy record shall be provided for each multi-mode fiber, at 850 nm and 1,300 nm.

G. Polarized Modal Dispersion (PMD) for each single mode fiber shall be measured using a PMD analyzer and polarized light source.

H. Chromatic optical dispersion shall be tested for each single mode fiber.

I. Certified copies of tests results shall be submitted to the Engineer as described in these specifications 14 days after completion of each test.

PART 3- EXECUTION

3.01 INSTALLATION

A. All optical cable installation shall be accomplished in accordance with the approved plan.

B. All horizontal and backbone LAN fiber optic cable shall be installed in inner-duct. OSP fiber optic cable shall be installed in inner-duct at locations outside of the wayside trough as indicated in the Contract Drawings, through manholes, and through duct bank conduits. All duct bank four inch communications conduits serving fiber optic cable shall contain four 1 inch inner-ducts each. No more than one OSP fiber optic cable shall be installed in a single inner-duct. The inner-duct shall be installed without coils or twists.

C. Pull locations shall be selected to protect the cable on the reel and in slack loops. Be responsible for protecting cable after working hours where cable installation is not completed during a single shift. Cables damaged due to Contractor’s negligence while installing cable shall be replaced.
D. Pull lengths shall be designed to allow a 20 percent margin in cable tensile strength. Do not exceed the lesser of 80 percent of the cable's maximum tensile rating or 600 lbs during installation. No residual tension shall remain on the cable after installation except that due to the cable's weight in the vertical rise. Wire Pulling Lubricant shall be used to reduce tension on the cable during the installation process.

E. If a winch or pulling machine is used during installation, a dynamometer shall be used to monitor the tension on the cable. The dynamometer shall be certified as calibrated and shall hold the peak value of the cable pull. The peak value shall be recorded and forwarded to the Engineer as part of the installation test data submittals.

F. The maximum vertical rise shall be defined as the distance over which the cable is self-supporting. Cable strain relief shall be used at the top of each vertical rise and no less than every time that 80 percent of vertical rise rating of the cable is exceeded.

G. Do not exceed the cable's minimum bend radius for cable under tension or long term installation/storage.

H. Continuity of cable shall be maintained between termination or splice locations shown on the Contract Drawings. Additional splices shall not be allowed without the prior written Engineer approval.

I. Notify the Engineer in writing at least 48 hours in advance of installation of each section of optical cable.

J. All cable entrance openings in equipment enclosures, houses, rooms and junction boxes shall be sealed with either a compression type fitting or pliable sealing compound after the cable is in place. Sealing compounds for rooms, houses, walls, or other partitions shall be fire retardant per ASTM E-814. Sealing compound shall be used to seal the area around cable where the cable emerges from the end of a conduit, pipe, or duct bank. All spare conduits shall be sealed or plugged in an Engineer approved manner.

3.02 TERMINATION

A. Slack in Fiber Slack Enclosures (FSE's) shall be carefully coiled in order to avoid violating the short and long term minimum bend radius. Supply a minimum of 150 feet of slack at each termination of the cable inside the FSE.

B. Slack in Fiber Distribution Panels (FDP's) shall be restrained and shall be sufficient for strain relief.

C. The central strength member of cable shall be attached to the FDP. The outer jacket of cable shall be attached to the FDP with a cable clamp.

D. All fiber optic splices shall be fusion splices. Perform splicing at fiber slack enclosures only for the purposes of passing an optical connection through a Communications House. Fusion splicing shall be performed by qualified personnel utilizing a splicer equipped with Local Injection and Detection (LID) to
optimize splices. The loss across each spliced fiber shall be less than or equal to 0.04 db.

E. All fiber optical terminations at communications houses and wayside facilities shall be field or factory terminated.

F. Notify the Engineer in writing at least one week in advance of terminating each section of optical cable.

G. Where armored cable is utilized, the armor shall be grounded to the communications room ground bus at one termination location.

3.03 FIELD QUALITY CONTROL

A. Cable Factory Tests: See Source Quality Control herein.

B. Cable Plant Field Tests:

1. Tests shall be performed after installation is complete.

2. One week advance notice to the Engineer shall be provided.

3. Optical attenuation from FDP to FDP shall be recorded.

4. Every fiber optic cabling link shall be tested in accordance with the field test specifications defined by the TIA-568-B.3 (or by the required network application standards) whichever is more demanding.

5. TIA-568-B.3 shall be used to define the passive cabling network, to include cable, connectors, and splices (if present), between two optical fiber patch panels (connecting hardware). This TIA document shall be used to describe all applicable link segments. Tests shall include the representative connector performance at the connecting hardware associated with the mating of patch cords but not the performance of the connector at the interface with the test equipment.

6. All of the cabling links installed shall be tested and shall pass the requirements of the standards mentioned in above. Any failing link shall be diagnosed and corrected prior to the system acceptance. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with Section 3.04 below.

7. Trained technicians who have successfully attended a required training program and have obtained a certificate, as proof thereof shall be used to execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:

a. The manufacturer of the fiber optic cable and/or the fiber optic connectors
b. The manufacturer of the test equipment used for the field certification

c. Training organizations authorized by BiCSI (Building Industry Consulting Services International), or by the ACP (Association of Cabling Professionals™).

8. Field test instruments for multimode fiber cabling shall meet the requirements of TIA-526-14. The light source shall meet the launch requirements of TIA-455-78. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap (as described in clause 11 of TIA-568) with a Category 1 light source. Field test instruments for single mode fiber cabling shall meet the requirements of TIA-526-7.

9. The test instrument calibration date shall be within the calibration period recommended by the vendor in order to achieve the vendor specified measurement accuracy.

10. The fiber optic launch cables and adapters shall be of high quality and the cables shall not show excessive wear resulting from repetitive coiling and storing of the test instrument interface adapters.

11. The Pass or Fail condition for the link-under test is determined by the results of the required individual tests.

12. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter.

13. An Engineer representative shall be invited to perform field-testing. The representative shall be notified of the start date of the testing phase five business days before testing.

14. The Engineer’s representative shall select up to five percent of the links installed. The representative (or his authorized delegate) shall test these selected links and the results are to be stored in accordance with the prescriptions in this Section. The results obtained shall be compared to the data provided by the Contractor. If the sample results differ in terms of the pass/fail determination, repeat testing of the affected link under observation of the Engineer.

C. Cable Plant Performance Test Parameters:

1. In compliance to TIA 568, the single performance parameter for field-testing of fiber optic links shall be link attenuation (insertion loss).

2. The link attenuation shall be calculated by the following formulas specified in ANSI/TIA/EIA 568:

   a. Link Attenuation = Cable Attenuation + Connector Attenuation + Splice Attenuation

   b. Cable Attenuation (db) = Attenuation Coefficient (db/km) x Length (km)
c. Connector Attenuation (db) = number of connector pairs x connector loss (db). Maximum allowable connector loss = 0.75 db

d. Splice Attenuation (dB) = number of splices (S) x Splice loss (db). Maximum allowable splice loss = 0.3 db

e. The values for the Attenuation Coefficient are listed below:
   i. Single mode (outside plant), 1310nm: 0.5 db/km
   ii. Single mode (outside plant), 1550nm: 0.5 db/km
   iii. Multimode, 850 nm: 3.5 db/km
   iv. Multimode, 1300 nm: 1.5 db/km

f. Link attenuation shall not include any active devices or passive devices other than cable, connectors, and splices, i.e., link attenuation shall not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.

g. Test equipment that measures the link length and automatically calculates the link loss based on the above formulas is preferred.

3. The above link test limits attenuation is based on the use of the One Reference Jumper Method specified by TIA-526-7, Method A.1; or the equivalent method. The user shall follow the procedures established by these standards or application notes to accurately conduct performance testing.

4. Multimode distribution links shall be tested at 850 nm and 1300 nm in accordance with ANSI/EIA/TIA-526-14. Because backbone length and the potential number of splices vary depending upon site conditions, the link attenuation equation shall be used to determine limit (acceptance) values.

5. Single-mode backbone links shall be tested at 1310 nm and 1550 nm in accordance with TIA-526-7, Method A.1, One Reference Jumper or the equivalent method. All single-mode links shall be certified with test tools using laser light sources at 1310 nm and 1550 nm.

6. Links to be used with network applications that use laser light sources (under-filled launch conditions) shall be tested with test equipment based on laser light sources. This rule shall be followed for cabling systems to support Gigabit Ethernet. Gigabit Ethernet only specifies laser light sources. For Gigabit Ethernet compliant certification (IEEE Std 802.3Z application), use test equipment that uses a VCSEL (Vertical cavity surface emitting laser) at 850 nm (compliant with 1000BASESX) and a FP laser at 1310 nm (compliant with 1000BASELX).
7. Each fiber optical link terminated with an optical adapter system that does not impose a transmission direction because the adapters are not or cannot be ganged shall be tested and documented in both directions since the direction of the signal transmission cannot be predicted at the time of installation.

D. OTDR Testing:

1. All cables shall be OTDR tested at 1310 nm and 1550 nm (for Single-mode) operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.

2. OTDR tests shall be performed utilizing a pulse suppressor such that the FDP termination shall be shown.

3. All OTDR testing procedures and field test instruments shall comply with applicable requirements of:
   a. TIA 455-78
   b. TIA 455-133

4. Each fiber link and channel shall be tested in one direction.

5. A launch cable shall be installed between the OTDR and the first link connection.

6. A receive cable shall be installed after the last link connection.

7. Optical Return Loss (ORL) for each link shall be measured.

8. Fiber Length shall be measured

9. Test Results:
   a. Reflective events shall not exceed -40 dB
   b. Connections shall not exceed 0.75 dB of attenuation
   c. Non-reflective events (splices) shall not exceed 0.3 db
   d. Point discontinuities shall not exceed 0.1 db
   e. ORL shall be less than -30 dB

10. OTDR Test results shall include OTDR link and channel traces and event tables at the required wavelength(s) and the length for each optical fiber as calculated by the OTDR.

11. An Optical Spectrum scan of each link shall be performed using an optical spectrum analyzer and optical switch to examine fiber nonlinear effects including but limited to Brillouin scattering and four wave mixing across the fiber’s usable light spectrum.
12. Polarized Modal Dispersion (PMD) for each link shall be measured using a PMD analyzer and polarized light source. Total PMD for each link shall be less than 10 ps.

E. Cable Plant Test Result Documentation:

1. The test result information for each link shall be recorded in the memory of the field tester upon completion of the test.

2. The test result records saved by the test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee shall be made that these results are transferred to the PC unaltered, i.e., "as saved in the tester" at the end of each test. The popular 'csv' format (comma separated, value format) does not provide adequate protection and shall not be acceptable.

3. The database records of all fiber shall be stored and delivered on CD-ROM; this CDROM shall include the software tools required to view, inspect, and print any selection of test reports.

4. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information.

   a. The identification of the link in accordance with the naming convention defined in the overall system documentation.
   
   b. The overall Pass/Fail evaluation of the link-under-test including the Attenuation worst-case margin (margin is defined as the difference between the measured value and the test limit value).
   
   c. The date and time the test results were saved in the memory of the tester.

5. General Information to be provided in the electronic data base containing the test result information for each link:

   a. The identification of site
   
   b. The overall Pass/Fail evaluation of the link-under-test
   
   c. The name of the standard selected to execute the stored test results
   
   d. The cable type and the value of the 'index of refraction' used for length calculations
   
   e. The date and time the test results were saved in the memory of the tester
   
   f. The brand name, model and serial number and calibration data of the tester
g. The revision of the tester software and the revision of the test standards database in the tester

6. The detailed test results data to be provided in the electronic database for each tested optical fiber shall contain the following information.

a. The identification of the link/fiber in accordance with the naming convention defined in the overall system documentation.

b. The insertion loss (attenuation) measured at each wavelength, the test limit calculated for the corresponding wavelength and the margin (difference between the measured attenuation and the test limit value).

c. The link length shall be reported for each optical fiber for which the test limit was calculated based on the formulas specified herein under Cable Plant Performance Test Paragraphs.

END OF SECTION
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):
   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: 8.8 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
SECTION 17750
VISUAL MESSAGE SIGN

PART 1 – GENERAL

1.01 DESCRIPTION
A. Section includes requirements for a Visual Message Sign (VMS) for passenger stations as a subsystem of Caltrain station communications.

1.02 REFERENCE STANDARDS
A. National Fire Protection Agency (NFPA):
   1. 70 National Electrical Code (NEC)
B. Telecommunications Industry Association/Electronics Industries Alliance (TIA/EIA):
   1. 568-B Commercial Building Telecommunications Cabling Standard (including B.1, B.2, and B.3)
   2. 606-A Administration Standard for the Telecommunications Infrastructure
C. Americans with Disabilities Act (ADA):
   1. Federal Transit Administration 49 CFR Part 37 Appendix A
D. Department Of Defense Design Criteria Standard:
   1. MIL-STD-1472 Military Standards
E. Underwriters Laboratories (UL):
   1. UL-969 Standard for Marking and Labeling Systems

1.03 SYSTEM REQUIREMENTS
A. The Visual Message Sign shall provide a visual display of dynamic messages, including timetable, listing of arrival and departure times for trains; commuter rail delays, status, or travel updates; alternate service plan advisories; general safety and security advisories; construction activities and interruptions; marketing messages; and local events, emergency and security announcements.

B. Visual Message Sign equipment shall include matrix display signs with attached sunshades, cabling, and all other equipment defined in this Section and as shown on the Contract Drawings.

C. Each VMS shall be individually addressable from the Central Control Facility (CCF).
D. The VMS shall be capable of displaying both text or graphic images.

E. The VMS shall be readable under all lighting conditions, including direct low-angle sunlight. The intensity and brightness of the displays shall be automatically controlled by a compensation circuit that senses ambient light conditions.

1.04 SUBMITTALS

A. Refer to Section 17000, Basic Communications Technical Requirements, for related and additional submittal requirements.

B. Submit detailed catalog cut sheet including dimensions of the VMS.

C. Submit structural design, including drawings and calculations for tube steel support members and concrete footings with seismic zone 4 designs, signed and sealed by a Structural Engineer licensed in the state of California.

D. Submit installation drawings no later than 14 days prior to installation of the VMS. Proceed with the installation only after the Engineer approval of installation drawings.

E. Testing: Submit test plan and procedures at least two weeks prior to commence of testing the VMS. Submit, within 15 days after conclusion of system testing, a report of final Test Procedures and the Results obtained from these tests.

F. As-Built Documentation: Submit complete As-Built documentation and drawings, as specified in Section 17000, Basic Communications Technical Requirements, for VMS equipment.

G. Operation and Maintenance Data: Provide documentation containing complete details of the delivered VMS equipment including operating and maintenance procedures and manuals.

1.05 SOURCE QUALITY CONTROL

A. The functional tests shall fully exercise the system and determine functional compliance as follows:

1. Test each electronic component of the VMS prior to shipment to the project site. Test results shall be submitted for Engineer approval.

PART 2 – PRODUCTS

2.01 VISUAL MESSAGE SIGNS (VMS)

A. Each VMS shall be individually addressable from the assigned CCF for sending information, configuring memory, and for investigating the contents of memory.

B. The VMS at the station shall be operable either from the assigned CCF or a local input device connected directly to the VMS.
C. Locally generated visual messages shall take priority over the assigned CCF generated messages.

D. The VMS shall be capable of displaying both text or graphic images on a large bright screen of high intensity light emitting diodes (LED). The display shall have the following characteristics:

1. Visual character heights
2. Automatic intensity control
3. 30 degrees from center axis
4. Multiple fonts
5. Multiple display effects; flash, scroll, roll, graphics
6. One to multi-line text

F. Each VMS shall be capable of storing 32 preprogrammed messages.

G. The VMS shall automatically lower its peak intensity in concert with ambient light conditions. Adjustment shall range from 25 percent level to 100 percent level.

H. The VMS shall be equipped with manufacturer’s standard sun shade.

I. VMS systems shall be supplied in single or double sided configuration as required by the Station design. Single sided VMS shall have the same display characteristics as the double sided described in this Section.

J. Supply double-sided visual message as shown on the Contract Drawings. The double-sided message boards shall be Daktronics Model Galaxy AF-6300 Part No. AF-6300-32X192-8-A-DF or Engineer approved equal. Each VMS shall conform to the following:

1. Display Characteristics:
   a. Luminance: amber – 4,000 cd/m2 (Nits) brightness
   b. Effects: flash, scroll, travel, roll, split, graphics
   c. Character height: variable
   d. Messages: multi and single line, minimum requirements of 2-lines of text, each line a minimum of 4” high and legible from 200 feet to meet ADA Standards for Transit Facilities.
   e. Viewing angle: 30 degrees to either side of perpendicular

2. Physical Characteristics:
   a. Enclosure: NEMA 4X
b. Enclosure length: 62.5 inches maximum

c. Display window: shatter-proof, vandal resistant, ultra-violet resistant, condensation prevention

d. Metal components: corrosion resistant

e. Maintenance access: access doors on each side of double-sided sign

3. A computer cable port shall be included to allow local messages to be generated via a laptop computer.

J. Cables: Cables shall conform to the requirements of Sections 16100, Wiring Methods, and 17120, Communications Wires and Cables.

K. Network Connectivity: The VMS shall come equipped with a factory installed 10/100 Mbps Ethernet to serial converter with a standard RJ-45 port or fiber optic interface port for connection to the Station LAN equipment.

L. The VMS system shall be compatible with Daktronics Model Venus 1500 display control system software.

M. Extend Caltrain’s current Venus 1500 VMS software license from Daktronics with the Enterprise license extension for each new VMS display provided.

M. The VMS displays shall be powered by Uninterruptable Power Supplies to prevent loss of emergency passenger communications for 90 minutes.

N. Mounting: Provide the VMS mounting as shown on the Contract Drawings, including all foundation work, stanchions, mounting brackets, and bracing.

N. Stanchions used for VMS mounting shall have an installed full-length divider to separate communication wiring from power wiring, or internal flex raceway for communication wiring.

2.02 EQUIPMENT RELIABILITY

A. All VMS equipment shall have a Mean Time Between Failures (MTBF) of at least 100,000 hours.

B. Maximum time to repair or restore the VMS provided shall not exceed one hour (from arrival of a maintenance technician at the site of the fault or failure) in the event of fault or failure of any subsystem or physical unit excluding cabling which runs in conduit. Equipment availability shall be such that only one side of one VMS sign is inoperative at any given time.
PART 3 - EXECUTION

3.01 INSTALLATION

A. All materials and installation necessary to complete the VMS System work shall conform to the requirements of the applicable standards and in accordance with the manufacturer’s recommendations.

B. Provide complete electrical and mechanical design for the installation of the VMS equipment.

C. Provide necessary conduit and wiring, both power and data, to complete the VMS installation. Where two or more VMS are connected to the dual Ethernet switches at the same DC (Distribution Cabinet), for redundancy, connect odd number VMS to first Ethernet Switch and even number VMS to the second Ethernet switch.

D. Verify that all equipment is the appropriate model, properly installed and connected in accordance with the Contract Drawings. The quality of the installation shall be demonstrated by tests for continuity, visual inspection and any other tests required by this Section.

E. Install VMS stanchions, including pole, support arms, and foundation, as shown on the Contract drawings and as specified in the Contract Specifications.

F. Mount VMS on stanchions. Verify that all mechanical connections are made and secure.

G. Apply all IP addresses to the VMSs as required by Owner’s network standards and recorded in the network Domain Name Server. All IP addresses shall be issued by the Caltrain IT network administrator. If required by the Caltrain administrator, implement VMS VLAN.

H. Perform startup of the VMS.

3.02 VMS INSTALLATION FOR STATIONS

A. Mount enclosures on tube steel support members. Locations are shown on the Contract Drawings. Mounting hardware and mounting arrangement shall be in accordance with Contract Drawings and manufacturer’s recommendations. The VMS shall be secured and plumbed, and clearly viewable by the passengers.

B. VMS support columns shall be securely attached to concrete footing.

C. Mount VMS to provide a minimum 8 foot 2 inch vertical clearance and a maximum 9 foot from the platform floor to the bottom of the VMS.

D. The end of the VMS sign shall not extend beyond the horizontal arm of the support pole in the direction of the tracks.

E. The VMS shall be mounted to the support pole to meet seismic zone 4 code.

F. Repair any damage done to existing equipment (e.g. supports, wires, or similar items) to the satisfaction of the Engineer.
3.03 CABLE INSTALLATION AND TERMINATIONS

A. Cables in Conduits:
   1. Verify that communications conduits have been inspected and cleaned prior to cable installation. Conduits shall have a clean, smooth concentric interior surface.
   2. Crossover of cables shall be avoided when cables are pulled into conduits. Care shall be taken not to have the conductors pulled tight or twisted in conduit fittings or boxes. All cables to be installed in a single conduit shall be pulled simultaneously.

B. Verify that all cables are properly routed, supported, terminated and labeled.

C. Wires and cables shall be continuous without splices between junction boxes, terminals, pull boxes, manholes and hand holes.

D. Terminate the cables installed between the VMS and the communications cabinets. The termination shall allow quick disconnection of the VMS.

3.04 FIELD TESTING

A. Perform tests in accordance to the Engineer approved test plan and procedures.

B. Field tests shall include functional and operational tests of equipment for all message features from the CCF as well as at the station.

C. The functional tests shall fully exercise the system and determine functional compliance as follows:
   1. Perform end-to-end tests for every control and indication point.
   2. Verify that all equipment is installed in its proper location in accordance with the approved design. Verify that all mechanical and electrical connections are made and secure.

D. Perform the following Operational tests:
   1. Verify full functional communication between the CCF and each of the existing stations.
   2. Verify all features are available at each of the Control Consoles at the CCF and they work as specified with the station.
   3. Verify on each VMS the display of the CCF generated messages at the station.
   4. Verify on each VMS the display of messages generated on a locally connected laptop computer at the station.
E. Perform integrated system testing to ensure full functionality with all existing systems of which the VMS is a part.

END OF SECTION
SECTION 17790
COMMUNICATIONS NETWORKS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes requirements for the Caltrain WAN/LAN network equipment and components required to connect station system and service to the assigned Central Control Facility (CCF) and Caltrain headquarters in San Carlos. The network shall be based on the TCP/IP suite of protocols.

B. Section also includes requirements for Clipper WAN/LAN network equipment and components required to connect station Card Interface Devices to the Clipper WAN.

1.02 CALTRAIN COMMUNICATIONS NETWORKS SYSTEM DESCRIPTION

A. In the station, provide new (or update the existing) data T1 service with serving speeds of up to a “full” T1 (1.544 Mbps) to connect the TVM/VMS/PA/CCTV to the Caltrain WAN (Wide Area Network).

B. Provide all necessary conduits, cables, and cabinets to interconnect the local communications provider MPOE (Main Point of Entry) to the station CER (Communications Equipment Room). Note that, in absence of CER, some Caltrain stations may still utilize outdoor Station Communications Cabinets (SCC) also sometimes referred to as Communications Interface Cabinets (CIC). It is the intent that the SCC’s/CIC’s be phased out and upgraded to CER’s. In this Section, for simplicity, the terms “SCC” and “CIC” are omitted. The term “CER” is used instead and it covers all types of station central Communications equipment implementation.

C. Coordinate with the local communications provider in the design phase to setup the MPOE in the station under the local communications provider requirement.

D. Provide all necessary material, labor, and equipment to affect the frame relay service in the station.

E. Provide dual 1000 Base Managed Ethernet switches at each station CER to interconnect the router and all other network devices. The station CER Ethernet switch shall have minimum capacity of twenty-four 10/100 Base T/TX port (12 of which shall be PoE compliant) and four single-mode fiber capable GBIC-based ports. Each switch shall be sized for an adequate number of GBIC, 10/100 Base T ports and PoE enabled 10/100 Base T ports to service the required number of subsystem devices assigned, plus 50% spare ports. At the current stage, the Station design will not include the interconnection by a Caltrain wide area fiber network. However, the station CER Ethernet Switches shall have two (out of four) single mode GBIC expansion ports assigned and programmed as spare for this future wide area fiber network.

F. Provide dual 1000 Base Industrial Managed Ethernet switches at each station distribution cabinet. Each switch will be sized for an adequate number of 10/100
Base T ports and PoE enabled 10/100 Base T ports to service the required number of subsystem devices assigned, plus 50% spare ports.

G. Use a single-mode fiber optic ring topology for all station 1000 BASE FX switch interconnectivity.

H. GBIC modules shall be provided for each GBIC-based port in the switch.

I. In a new station, furnish and install a router device with the necessary CSU/DSU (Channel Service Unit/Data Service Unit) and Ethernet module. The router shall interconnect the station network equipment in the station to Caltrain WAN. The router shall have a minimum of four expansion slots with four built-in 10/100 Ethernet ports.

J. Dual 1000 Base (GigE) Ethernet switches shall be installed in the Communications Equipment Room (CER) and each field communications distribution cabinet per the Contract Drawings. Station CER and DC GigE switches shall be assigned to the single-mode fiber optic backbone and interconnected in a dual redundant physical ring topology. For redundancy, station field devices (such as TVM and VMS) serviced by these dual switches shall be divided into two groups: first group will be served by one distribution switch; the second group will be served by the second distribution switch. The dual switches shall be programmed in such a way that, if one of them fails, field devices connected to the failed switch could be manually reconnected to the remaining (healthy) switch ports.

K. All switching networking equipment will be located in the station Communication Equipment Room (CER) and station distribution cabinets (DCs). Subsystem devices shall be serviced from the distribution cabinet using copper (TIA/EIA Category 6) cable. Where required by design, the subsystem devices shall be PoE powered by the switches over the Category 6 cables. Subsystem devices with integrated networking (switching) and direct fiber interfaces shall be serviced directly from the CER using single-mode backbone cable, eliminating the need for intermediate network electronics.

L. All network equipment, related protocol/media converters and any other active equipment connecting Station systems to the Station network require UPS-backed power, which shall be rated for provision of non-interrupted service for at least 90 minutes in the event of loss of utility power.

M. Provide any required stand-alone field media converter/switch for each subsystem device requiring protocol conversion. Interfaces and network topology for subsystems are described in Division 17 Specification Sections related to that subsystem. Fiber Optic Media converters and single-mode cabling shall be used when the Category 6 cable run to the subsystem device exceeds 300 feet from the serving Ethernet Switch in CER or DC (whichever is closer). If such subsystem device requires PoE power, the Media Converter shall support provision of 10/100Base-T with PoE output. For such applications, the single-mode runs shall be accompanied with power wiring delivering UPS-backed power to the remote Media Converter with PoE.

N. Wireless equipment to connect an extended range system device to the distribution cabinet where conventional UTP or fiber cable placement is not feasible.
possible shall be furnished and installed with Engineer’s approval. For example, where a required CCTV camera placement would exceed the cable distance limitations set forth in TIA/EIA 568-B, a wireless link can be used, with the Engineer’s approval.

O. Access requests to the Caltrain network require consultation with the Engineer; upon Engineer’s approval, provide a firewall router to access the Caltrain network.

P. Should network equipment specified herein become obsolete or should an upgrade model become available, replace the specified equipment with most current available model with Engineer’s approval. Submit full technical specifications for the replacement equipment for Engineer review prior to purchase.

Q. Test and make operational all specified equipment required to operate all communications subsystems in a station using the TCP/IP Ethernet network.

1.03 CLIPPER COMMUNICATIONS NETWORK SYSTEM DESCRIPTION

A. Clipper station communications network is independent from Caltrain station communications network. Clipper establishes the frame relay service in a station to connect the Clipper WAN to the station Clipper CID (Card Interface Device) LAN. Clipper provides for the station CID Router, CID Ethernet Switches and CID devices (Caltrain provides for the CID poles and poles temporary covers). The typical design of the CID network is of traditional non-redundant star topology, which includes: CID Router at CER for WAN/LAN interface connected to the CER Ethernet Switch, which in turn utilizes station single-mode fiber backbone for connection to the CID Ethernet Switches placed within DCs. The CID Ethernet Switches within DCs provide for CID LAN connection to the adjacent CID card readers over Category 6 cabling, utilizing existing Category 6 patch panel equipment within DCs. The CID devices have to be powered by 24VDC power supplies installed within the DCs. The actual project Clipper communications network implementation may vary, see the project Contract documents for the Clipper network design requirements and implementation details.

B. Provide all necessary rack space, conduits, 24VDC power supplies, patch cords and cables to inter-connect the Clipper station communications network devices between MPOE (Main Point of Entry) to all station CIDs. Install all necessary poles and temporary pole covers. Note that, since Clipper communications network utilizes some of the Caltrain backbone cabling and patch-panel equipment, such Caltrain network equipment design shall accommodate these additional connections.

1.04 CALTRAIN COMMUNICATIONS NETWORK DESIGN REQUIREMENT

A. All network equipment shall be commercially available through multiple sellers or distributors. The manufacturers shall have implemented a standard Quality Assurance program such as ISO 9001 certification.

B. All network equipment shall include an SNMP agent for management. Management protocols supported shall include SNMP, RMON, and Telnet.
C. All network equipment shall have a minimum of five (5) years warranty from the manufacturer.

D. The network equipment shall be 19 inch EIA rack-mountable or DIN rail mountable.

E. All switches shall auto-detect full and half-duplex operation on all ports.

F. All switches shall support VLAN (IEEE 802.1Q), Rapid Spanning Tree Protocol (IEEE 802.1W), and Multiple Spanning Tree Protocol (IEEE 802.1S). The Ethernet dual redundant rings shall be configured for detection of failure and switchover to the healthy side of the ring within a few milliseconds of a failure.

G. The switch shall have embedded web-based management software with the ability to manage up to 16 switches at once.

H. No network equipment which has been retired from production, or reached End-of-Life, by the manufacture is acceptable for installation. Network equipment which has been scheduled for production End-of-Life shall be accepted only by Engineer’s approval.

I. All Ethernet switches shall be environmentally rated for operation within internal temperatures, vibration and shock, dust, surge and noise immunity ratings of the station CER and DCs.

J. All outdoor copper cabling connected to the CER or DCs switches shall utilize lightning/surge protection equipment at the point of entrance into those facilities.

1.05 SUBMITTALS

A. Refer to Section 17000, Basic Communications Technical Requirements, for related and additional submittal requirements.

B. Submit performance data descriptions or samples of all products furnished under this Section for Engineer review.

C. Submit application to the local communications provider and Engineer for the frame relay circuit, and PVC (Permanent Virtual Circuit) service in the station. The circuit shall meet the specification and requirement of the system in the station.

D. Submit shop drawings showing the details of interfacing the frame circuit from the MPOE to the station devices.

E. Submit network diagrams of the system including all interfaces and devices. Include specification cut-sheets for all proposed network components.

F. Submit the IP and VLAN addressing scheme for the station subsystems. The scheme shall be consistent with Caltrain network and assignment conventions.

G. Submit a Network list for all devices, showing proposed network addresses, subnets, gateways, mask assignments, VLANs and terminal address of each device.
H. Submit cabinet equipment vertical profile drawings depicting equipment placement in each cabinet. Submit thermo calculations showing that internal temperature of the cabinets will never exceed maximum allowed temperature ratings for the chosen switches and other network equipment.

I. Submit a complete bill of materials (BOM) for all network equipment and accessories.

J. Submit manufacture warranty documentations of all proposed network equipment described in this Section to the Engineer.

K. Submit a system cutover plan for approval no later than 30 days prior to the cutover.

L. Submit documentation to prove and demonstrate that the required steps prior to cutover specified in this Section have been completed seven (7) days prior to the cutover.

**PART 2 – PRODUCTS**

**2.01 STATION ETHERNET SWITCH**

A. The switch shall be furnished and installed in the station distribution cabinet. The switch shall be rugged switch designed for the harsh, rugged transit.

B. The switch shall be compliant with IEC-61850-3 and IEEE 1613 specifications for extended environmental, shock/vibration, and surge ratings; with a focus on redundancy; and convection cooling (no fans) with temperature ratings up to +60 degrees C (measured as continuous operating temperature range)

C. The switch shall be sized for an adequate number of 10/100 Base T ports and PoE enabled 10/100 Base T ports to service the required number of subsystem devices assigned, plus 50% spare ports.

D. The switch shall be equipped with at least two Single-mode GBIC modules.

E. The switch shall support IEEE Rapid Spanning Tree (802.1W) and Multiple Spanning Tree Protocol (IEEE 802.1S) for high resilience redundant fiber backbone connections.

F. The switch shall support PVST layer 2 load sharing on redundant ring links.

G. The switch shall support VLAN trunking protocol and 802.1Q.

H. The switch shall be the Cisco CGS-2520 series or Engineer approved equal.

**2.02 STATION AGGREGATION ETHERNET SWITCH**

A. Provide dual aggregation switches in the station CER. Each switch shall be connected to the Station LAN Ethernet switch using two GBIC-based ports via a Single-mode fiber ring topology (with additional two single-mode GBIC-based ports programmed as spare for connection to future Caltrain fiber WAN network).
B. The switch shall be sized for an adequate number of 10/100 Base T ports and PoE enabled 10/100 Base T ports to service the required number of subsystem devices assigned, plus 50% spare ports.

C. The switch shall be equipped with dual power supplies with hot swap capability and automatic failover.

D. The switch shall provide for routing and uninterrupted performance at Layer 2 and Layer 3.

F. The switch shall provide for ability to upgrade uplink bandwidth to 10 Gigabit Ethernet.

G. The switch shall provide for multitude of redundancy features, such as 1:N master redundancy; network resiliency and redundant fiber backbone connections through Rapid Spanning Tree IEEE Protocol (802.1W), etc.

E. The switch shall be the Cisco Catalyst 3750 series or Engineer approved equal.

2.03 STATION ROUTER

A. Router shall be a rack-mountable.

B. The router shall be a highly reliable with IP LAN connection and proper WAN interface module.

C. The router shall have two high speed Ethernet ports or modules.

D. The router shall be equipped with a minimum of 2GB memory to support remote and local VLAN's and required security configurations.

E. The router shall be equipped with dual power supplies with hot swap capability and automatic failover.

F. The router shall be CISCO 2900 integrated services or 3900 integrated services series or equal. Router is dependent on the type of network interface (T1, DSL, ADSL, OC3) used.

2.04 GBIC MODULES

A. The GBIC modules shall be furnished and installed to connect among the Station Aggregation Ethernet Switch and distribution Ethernet switches.

B. The GBIC modules shall meet or exceed the following specifications:

1. Support VLAN (IEEE 802.1Q), Rapid Spanning Tree (IEEE 802.W) and Multiple Spanning Tree Protocol (IEEE 802.1S) protocols

2. Support Layer 3 routing

C. The GBIC modules shall be provided with LC type fiber connector or SC type fiber connector if the LC type is not available from any manufacture and with the permission of the Engineer.
D. The switch shall have Single-mode GBIC modules available for future Station to Station connectivity but not supplied under this contract. Data sheets shall be submitted.

2.05 FIREWALL ROUTER

A. The firewall router shall be optionally provided as required by the Station network design.

B. The firewall router shall have an integrated 4 port 10/100 switch.

C. The firewall router shall have a lifetime warranty from the manufacturer.

D. The firewall router shall be the Cisco PIX525 bundle 50 or Engineer approved equal.

2.06 MEDIA CONVERTERS

A. Media converters used to interface the single-mode fiber optic cable at the subsystem device will be placed in the distribution cabinet (DC) associated with that device per the site specific plans. Media converters for TVM, VMS, and CCTV subsystems shall be dual 10/100 Base FX port with automatic ring path switching protection.

B. For remote devices requiring PoE, Media Converters shall provide for an Ethernet 10/100Base-T ports with IEEE 802.3af PoE.

2.07 UTP CAT 6 DISTRIBUTION PANEL

A. The Cat 6 48-port UTP distribution panel in distribution cabinet shall meet the following Specification:

1. Qualified Cat.6/Class E
2. Permanent Link/Channel of TIA/EIA568B-2.1 Cat.6
3. ISO/IEC11801 2nd Edition
4. EN50173 2nd Edition
5. IEC60603-7

B. The UTP Cat 6 patch panel shall be LEVITON 48-PORT PANEL CAT6 BLK 3U or Engineer approved equal.

2.08 UTP PATCH CORDS

A. Patch cords shall be Category 6, factory made, and not spliced and terminated on-site. They shall come in non-resonant standard lengths of 6 or 7 feet.

B. The patch cords shall have strain-relief RJ-45 connectors. The patch cords shall be rated as a minimum, Category 6 unshielded twisted pair cabling, and shall terminate all eight positions of the connector.
2.09 FIBER PATCH CABLE

A. Patch cords shall be complete factory fabricated assemblies from manufacture’s standard product line. They shall come in standard lengths of 6 or 7 feet.

B. Patch cords shall be of the same Fiber Optic characteristics as the backbone cable.

C. The patch cords shall consist of flexible cable with either SC or LC compatible connectors (as required for particular application).

D. The patch cords shall comply with the requirement of TIA/EIA-568-B.

E. Patch cords used for single-mode fiber will be colored yellow.

2.10 CABLE MANAGEMENT

A. Cable guides shall be specifically manufactured for the purpose of routing cables, wires and patch cords horizontally and vertically on 19-inch equipment racks. Cable guides shall consist of ring or bracket-like devices mounted on rack panels for horizontal use or individually mounted for vertical use. Cable guides shall mount to racks by screws and/or nuts and lock-washer.

2.11 LCD CONSOLE DRAWER

A. Rack mount console used for programming the equipment shall be furnished and installed in station distribution cabinet for each station.

B. The rack mount console shall include a monitor, keyboard and touch pad.

C. The rack mount console shall meet or exceed the following specifications:

1. Compatible with most PS/2 or USB type of KVM switches, to match provided computer equipment.

2. Integrated KVM console (88 key keyboard and touch pad) in a 1U rack mountable slide-away housing

3. Rack mountable in 19” system rack (1U)

4. Built-in touch pad

5. Power Consumption: 120V~230V; 50Hz~60Hz

6. Monitor Resolution (minimum): 1024 x 768

7. Operating Temperature: 0° - 50° C

8. Metal enclosure
2.12 KVM SWITCH

A. Rack mount KVM switch used for programming the router, switch and other device shall be furnished and installed in station distribution cabinet for each station.

B. The KVM switch shall meet or exceed the following specifications:

1. Use of keyboard, monitor and touch pad to control up to eight computers
2. Multilevel password protection
3. Quick view scan mode for monitoring selected computers
4. Operating System-independent operation
5. Connected PC can be added or removed from the setup without powering off the KVM switch
6. Plug-n-Play monitor support
7. Video resolution up to 1900x1200
8. LCD, SVGA, VGA and multisync monitor support
9. Mouse and keyboard emulation for system bootup
10. No software required to operate
11. LEDs for easy status monitoring
12. Rack mountable in 19" (1U) system rack

PART 3 – EXECUTION

3.01 INSTALLATION

A. Topology:

1. Each station (node) on the network shall have a physical address (Ethernet address), and shall be assigned with a logical (e.g., IP) address or a terminal ID. Where required, it shall also be assigned to the corresponding VLAN.

2. Program the IP address and terminal address to each system device accordingly to the IP address scheme approved by the Engineer.

B. LAN cabling:

1. Ducts carrying LAN cabling shall be installed in accordance with TIA/EIA-569-B and properly grounded according to TIA/EIA-J-STD-607-A and MIL-HDBK-419A standards.
2. LAN cable shall be routed away from all sources of interference, including power lines, motors, radio interference, fluorescent lighting, and heavy machinery.

3. The LAN cable shall be installed in inner duct and routed via protected risers and overhead raceway. Network equipment shall be installed to provide sufficient immunity from all electromagnetic disturbances.

C. Tagging:

1. Wire and cable shall be permanently tagged as specified in Section 17120, Communications Wires and Cables. Network configuration records shall be created and maintained. Tag labeling and network records shall be in accordance with TIA/EIA-606-A.

2. All jacks shall be identified using permanently mounted white tags with permanent black 1/8-inch minimum height lettering.

D. Station network equipment installation:

1. Provide an Access Router (Cisco 2900 or 3900 series or equal) at the main distribution cabinet to interface the network carrier. Connectivity from the network carrier (MPOE) to the Access Router shall be made with new conduit and wiring.

2. A Cisco 4-port 10/100 Fast Ethernet switch WIC (WAN Interface Card) card shall be installed to provide LAN connection to existing VMS matrix display. Provide the necessary software and hardware upgrade on the router to support the new module.

3. Install and position the station network equipment in cabinets or racks as shown on the Contract Drawings.

4. Install and position the distribution network equipment in cabinets or racks as shown on the Contract Drawings.

E. Central and station circuit upgrade and installation:

1. Be responsible for installing the Frame Relay services at the station, and shall establish and provide facility for setting up the frame relay service MPOE.

2. Install and setup a T1 circuit in the station.

F. Provide all equipment necessary, including router, WAN Interface Card, CSU/DSU, wiring and conduit for the Station and Central Control WAN upgrade.

G. Assist Clipper personnel with installation, termination and testing of the CID network devices.

H. Be responsible for the recurring cost of the new circuit during the test period and before the system and station cutover.
3.02 SYSTEM CUTOVER FOR A NEW AND REMODELED STATION

A. Submit a detailed system cutover plan based upon the requirements in this Section and the construction sequencing and cutover schemes.

1. This plan shall include all phases, and describe in detail how the objectives of elimination of system down time, and minimization of system disruption will be accomplished.

2. The new frame circuit and system shall be made operational and tested alongside the existing system in the station before the cutover.

3. The detailed cutover sequencing and order of work shall be subject to the Engineer’s approval.

4. Plan shall take into account Work Window from 1 am to 4 am for the TVM LAN and Clipper LAN cutover work; plan shall minimize TVM and CID service disruption.

B. Steps Prior to Cutover: The following is a summary of the steps required to be completed and documented seven (7) days prior to cutover the TVM/VMS system:

1. The new circuit and private virtual circuit (PVC) provisioning at each station, including any network upgrade, shall be installed and tested.

2. All cabinets including the communication rack/cabinet shall be installed with proper grounding.

3. All cabinets including the communication rack/cabinet shall be equipped with protective electrical outlets.

4. The conduit from the Telco cabinet to the communication rack/cabinet shall be provided.

6. The fiber cables from the station distribution cabinet to the distribution cabinets shall be installed and tested.

5. The UTP or fiber cable to the TVM machines, VMS signs, and other devices shall be terminated and tested.

6. UTP and fiber cable test result shall be submitted to the Engineer.

3.03 OPERATIONAL TESTS

A. General: Perform all manufacturers recommended equipment and cable testing. Perform all available equipment built-in unit and communications paired tests. Exercise and demonstrate as operational all equipment configuration, management, and diagnostic functions.

B. For new station Router and the new Ethernet Switches, perform the following additional tests:
1. Verify proper routing of network data from the WAN to the appropriate Station LAN and Node. Verify that the sub-net design allows test data to appear only at the intended destination(s).

2. Measure maximum throughput from the WAN to each station load under normal operating conditions.

3. Measure maximum throughput from each Distribution cabinet to central racks/cabinet.

4. Test all router and switch ports (including spares) to assure complete functionality at installation.

5. Observe the switch and router operating systems for indications of port errors and report all error rates above the vendor recommended maximum.

C. Assist Clipper personnel with their testing.

D. For station with wireless infrastructure, perform the following tests for all wireless links:

   1. Transfer a minimum of a 500-MB file through each wireless link.
   2. Measure and record transfer speeds.

END OF SECTION
SECTION 17800
PUBLIC ADDRESS SYSTEM

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes requirements for a Public Address (PA) system for passenger stations as a subsystem of Caltrain station communications, and that will function as an extension of the existing public address system network. These requirements are for standard Caltrain stations (center island platform or outboard platforms). For other applications (i.e. areas beyond station platforms, maintenance facilities, tunnels, multiple platforms, etc.) refer to the corresponding project additional specific requirements.

B. Coordinate and provide interfaces between the station Communications Equipment Room (CER) and the station PA subsystem. In absence of CER, some Caltrain stations may still utilize outdoor Station Communications Cabinets (SCC) also sometimes referred to as Communications Interface Cabinets (CIC). It is the intent to phase out the SCC’s/CIC’s and upgraded to CER’s. For simplicity, the terms “SCC” and “CIC” are omitted. The term “CER” is used instead and it covers all types of station central Communications equipment implementation.

1.02 REFERENCE STANDARDS

A. Electronics Industries Alliance (EIA):
   1. EIA 160 Sound Systems
   2. EIA-101 Amplifiers for Sound Equipment

B. Sound Equipment (SE):
   1. SE-103 Speakers for Sound Equipment
   2. SE-104 Engineering Specifications for Amplifiers for Sound Equipment

C. National Fire Protection Association (NFPA):
   1. NFPA 70 National Electrical Code (NEC)

D. Local noise ordinances

E. Building Industry Consultant Service International (BICSI):
   1. Telecommunications Distribution Methods Manual

1.03 SYSTEM DESCRIPTION

A. The PA system shall be used to provide train destination information and emergency messages to passengers, employees, and emergency response personnel. Primary communication of announcements shall be from the assigned Central Operations to the station via existing leased T1 lines or privately owned carrier network. The new
PA system shall also provide the capability to broadcast locally generated announcements and remote dial-in telephone announcements by the Caltrain users. The new PA system shall be either a new PA system installation at the new Caltrain station or a replacement of the existing PA system at the existing station.

1. The primary objective of the PA System is delivery to the passengers adequate levels of intelligibility of PA announcements.

2. PA equipment shall include phone input processing circuits, power amplifiers, premixers / ambient noise compensators, speakers, local paging and ambient noise sensing microphones, cabling, conduit, and all other station oriented equipment defined in this Section and as shown on the Contract Drawings.

2. Unless otherwise indicated in the Contract Documents, the PA system equipment shall be located in the new Station Communication Equipment Room (CER) and on the Station Platform(s). This shall also include station conduit and cabling network associated with the PA wiring.

3. The PA system shall provide for remote monitoring of local PA dry-contact alarms via UPS digital I/O sensing and reporting these PA alarms to the CCF UPS Monitoring software (at later time, Caltrain may use such digital I/O alarms for reporting via future SCADA). The Station PA shall also support future remote monitoring of local PA alarms via TCP/IP protocol to the Caltrain SNMP Network Management System utilizing Network Management cards at the pre-mixer and amplifier equipment.

4. Support Engineer in testing the operation of PA system at the stations from Central Control Facility (CCF).

5. Use of any component or device, not expressly specified herein, that is required to implement the work, shall be subject to the Engineer's approval of required submittals.

1.04 DESIGN REQUIREMENTS

A. General: Remote PA messages to the station shall originate from the CCF and from a dial-up line for the announcements over the phone by the Caltrain end users. At the station, the PA system shall announce these messages and, shall be capable of broadcasting locally generated announcements and messages.

B. Public Address (PA): There shall be one PA zone per each station platform. Depending on the quantity of the station platforms, the station shall be divided into one (one-platform station) or two (two-platform station) PA announcement zones. Each PA zone shall be served by the associated 2-channel amplifier and ambient noise sensing microphone. Each zone PA volume shall be increased/decreased according to the noise level measured by the corresponding ambient noise level microphone. All station PA measurements shall be performed at 5 feet above the floor level. The new PA system shall provide for the following measurements (measured at 95% of the station platforms):

1. The PA system shall provide intelligible output coverage at a levels 6 dB to 12 dB over measured ambient noise.
2. On station platforms the coverage shall be a uniform level of plus or minus 3 dB @ 1000 Hz Octave band.

3. The speech intelligibility of the PA system announcements (measured in STI-PA female index) shall be minimum 0.6.

C. Sound Level Adjustment: The PA system shall monitor the ambient sound level at the associated station area and automatically adjust the output level of the power amplifiers. The system shall also have the ability to automatically adjust the output of the system to meet day time and night time noise abatement requirements of local municipalities. It shall be programmed to filter out "clicking," "pitching" and any other unsettling sounds, which may occur during use of switches, push-to-talk buttons, rotation of volume controls and other potential similar origins. The PA system shall be programmed to eliminate positive feedback for all microphones used by the PA system. The system shall be programmed to implement timed hang-up function for any sources of PA announcements.

D. CCF PA messages: Messages from CCF will be communicated via DS0 leased (fractional T1) or privately owned telephone lines utilizing E&M messaging. The PA System shall be ready for the future VOIP implementation of the Caltrain communications system and shall be capable of accepting remote PA messages from CCF in following formats: a phone line input from the future IP-to-Analog Phone Gateway and/or audio line output from the future Station Control Unit computer.

E. Local PA messages: A push-to-talk microphone/handset shall be provided to enable the broadcast of local ad-hoc PA messages.

F. Cell/Public/Private Phone Messages: The PA system shall have the ability to broadcast ad-hoc PA messages via a cell, public, or private phone. To mitigate concern of "prank calls" to this line, a phone access device shall be implemented programmed with access codes given by Caltrain. The PA System shall be ready for the future VOIP implementation of the Caltrain communications system and shall be capable of accepting remote PA messages from cell, public, or private phone passed through the future IP-to-Analog Phone Gateway as a phone line input.

G. PA system shall implement message broadcast priority as follows: In-progress PA announcements shall be pre-empted according to the priority scheme defined below.

1. CCF PA: Top Priority
2. Local PA via push-to-talk microphone/handset: Second Priority
3. Cell/Public/Private Phone Messages: Third Priority

H. PA system shall have the ability to monitor the speaker loading of each output channel to determine if any speaker wire disconnects, breaks, wire grounding, speaker faults, or other speaker circuit changes have occurred and transmit an alarm via output dry contacts when a change is detected. Wire these dry contact outputs to the local UPS sensing inputs for transmission of this alarm information to CCF UPS Monitoring Software. In the future, these alarms will be wired to the Caltrain future SCADA system. The PA System shall also support secondary means of communications and transmission of such alarm/event information via its Ethernet network interface cards for the future SNMP based monitoring and control over the Caltrain LAN.
I. The CER UPS shall be programmed to monitor status of the PA System dry contact outputs wired to UPS inputs for reporting via the UPS networking cards such abnormal conditions to the existing Caltrain UPS APC Smart Monitoring system located at CCF. If necessary, the Contractor shall provide for data cabling interface between UPS networking cards and the station LAN.

J. All digital processor/digital mixer parameters shall be backed up via FLASH ROM, and not requiring battery backup. System configurations shall be capable of being stored for recall from any system presets from the front panel control, switch closure, via manufactures application software running under Windows O/S or scheduled from the internal real-time clock/calendar. If communication between the host computer and the digital processor/ digital mixer is lost, the unit shall continue to function with the last commands received.

K. The manufacturer’s software for remote configuration, performance monitoring, and alarm monitoring shall be acquired and tested. All functions shall be tested at the station sites as current station LAN installations permit. The software shall be able to remotely interface with the PA hardware via Ethernet and be able to:

1. Configure the mixer inputs, outputs, crossovers, and preset functions
2. Control the power output amplifiers gain
3. Be TCP/IP compliant to monitor equipment status via SNMP tools
4. Be TCP/IP compliant to receive equipment alarms via SNMP tools

L. Redundant Ethernet switch ports at the CER shall provision at least 100 Mbps for a separate PA Virtual Local Area Network (VLAN) to segregate the PA traffic from all others on the network.

M. The station PA VLAN shall share the station LAN 1000 Mbps Ethernet backbone bandwidth with other station subsystems. The station LAN 1000 Mbps backbone will operate in a physical ring topology via the station single-mode fiber optic cable.

N. For all locations where environmental control is not implemented, all equipment installed shall be treated as equipment exposed to the elements. The equipments’ design, materials, installation, mounting, termination and coatings shall be implemented with appropriate protection against exposure to elements. This protection shall still accommodate requirements of good maintenance.

1.05 SUBMITTALS

A. Refer to Sections 16000, Basic Electrical Requirements, and 17000, Basic Technical Requirements, for related requirements and additional submittals.

B. Design submittals: For each design level, include the following as a minimum:

1. Product Data: For each type of equipment. Submit performance data and descriptions or samples of all products furnished under this Section.
2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location of each field connection. This shall include but not be limited to rack layouts and wiring diagrams, termination details, installation and
demolition drawings with final equipment placement based on the findings in the field, installation details, design drawings depicting deviations from the bid documents.

3. Product Certificates: Signed by manufacturers of equipment certifying that products furnished comply with specified requirements.

4. Installer Certificates: Signed by manufacturer certifying that installers or technicians are capable of complying with requirements.

5. Manufacturer Certificates: Signed by manufacturers certifying that they comply with requirements.

6. Design documentation depicting termination details and conduit/cabling/terminals labeling.

7. If applicable, design documentation regarding the cutover process and phases for switching from the existing PAS to the new PAS. This should also include methods to reduce Caltrain downtime.

8. Design documentation describing software and hardware configuration settings for all equipment affected by the project (including network, PA and UPS devices configs and alarm setup, etc.).

C. Submit installation drawings no later than 14 days prior to installation of PA system.

D. Testing: Submit, 30 days prior to system testing, Test Procedures and the description of the intended Test Equipment. The Test Procedures shall demonstrate how the new PA system meets each design requirement from the subpart 1.04 above.

E. Test Results: Submit, within 15 days after conclusion of system testing, a report of final Test Procedures and the Results obtained from these tests.

F. Qualifications: Submit resume showing installer qualifications.

G. Maintenance Data: For equipment to include in training and maintenance manuals specified in General Provisions. Training shall include operation, maintenance and trouble shooting of the new PA System for the Caltrain.

H. As-Built Documentation: Submit as-built documentation as specified in Section 17000, Basic Communications Technical Requirements, including all changes to approved Contract Drawings incorporated in the final installation, within 6 weeks after installation completion. The asbuilt documentation shall describe final equipment layout, installation details and the software configuration settings.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Demonstrate that the team members had previously worked on at least two successful projects of similar nature and similar hardware. Additionally, minimum three years experience installing and maintaining equipment required for this Section; and shall be an authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this Section.
PART 2 – PRODUCTS

2.01 GENERAL

A. For other materials and products, refer to Section 17000, Basic Communications Equipment, Materials, and Methods, and Section 17120, Communications Wires and Cables.

2.02 EQUIPMENT

A. Unless superseded by the individual requirements stated herein, PA system electronic components shall conform to the following general requirements:
   1. Solid state design
   2. UL listed
   3. Latest manufacturer design
   4. Balanced outputs
   5. EIA 19-inch rack mountable

B. Trumpet Type Loudspeakers shall conform to the following:
   1. Rated for outdoor use
   2. Throw: 60 feet
   3. Include mounting hardware for mounting to wood/metal poles and surface/ceiling mounting.
   4. Frequency Response Voice: 250-3,000 Hz
   5. Frequency Response Music: 140-20,000 Hz
   6. Dispersion Coverage: 120° H x 90° V
   7. Speakers shall be the Atlas Sound, model APX40TN or Engineer approved equal
   8. Color: Match the color of the attachment surface for wall mounted speakers, as approved by the Engineer

C. Audio Output Power Amplifiers: Power amplifiers shall conform to the following:
   1. Configuration: The power amplifier shall be selected as one 2-channel amplifier per a platform. The power amplifier(s) shall be installed utilizing separate ‘A’ and ‘B’ channels. A platform shall configure ‘A’ and ‘B’ channels to alternating speakers on the same speaker poles. Amplifier input shall match the outputs of the Pre-Mixer/Pre-amplifier and accommodate its PA zone specific ambient noise compensator.
   2. Frequency Response: 50 Hz to 15 kHz ± 0.3 dB
3. Output Level: Constant 70.7 volts (nominal), transformer isolated
4. Overload Protection: Output Current Limited, Thermal Overload
5. Output Power: At least 25 percent greater than the required output power (10 dB above nominal) at station nominal sound pressure levels with a minimum of 600 Watts per channel.
6. Harmonic Distortion: Maximum 0.5 percent from 30 Hz to 10 kHz
7. All indicators and controls shall be accessible from the amplifier front panel
8. Local serial access port following RS232 Data Communication specifications:
   a. Baud Rate: Selectable to 19.2K, 38.4 K, 57.6 K, or 115.2 K BAUD
   b. Data Format: Serial, binary, asynchronous; 1 start bit; 1 stop bit; 8 data bits; no parity to allow initial configuration input, configuration changes, and monitoring of system status.
9. Have an Ethernet interface module, which allows for remote control, monitoring, and generation of alarms via 100Mbs Ethernet to monitor equipment status via SNMP tools or provide equal SNMP functionality.
10. The Ethernet interface module shall be the Crown IQ-PIP-Lite or Engineer approved equal.
11. EIA 19-inch rack mountable
12. The amplifier shall be the Crown CTs1200 or Engineer approved equal.

D. Pre-Amplifier/Pre-Mixer equipment:
1. The Pre-Amplifier/Pre-Mixer shall conform to the following:
   a. Continuous adjustments from 1 second to 5 minutes for sampling of ambient noise conditions to provide a zero time delay for announcements.
   b. Automatic adjustment range: 10 to 30 dB
   c. Sense Channel: 250 Hz to 4 kHz +/- 1 dB
   d. Expand or attack and release times: 3 to 25 seconds adjustable attack time and 15 to 120 seconds release time.
   e. Support “BLU-LINK” capability to enable intercommunications with additional standalone rack-mount Pre-mixer expansion modules (BSS Audio, model BLU-BIB and/or BSS Audio, model BLU-BOB1 or approved equal) providing for expansion of Line/Mic inputs and outputs for the power amplifiers.
   f. Support reporting of abnormal/alarm conditions via the dry output contacts.
g. Provide for slots to accept:
   i. Analog Input Modules, each providing for 4 line/mic inputs
   ii. Hybrid Input Modules, each providing for 1 phone and 2 line/mic inputs

h. Provide for flexible software allowing for the following:
   i. monitoring the ambient sound level at the associated station area and automatically adjust the output level of the power amplifiers
   ii. ability to automatically adjust the output of the system to meet day time and night time noise abatement requirements of local municipalities
   iii. filter “clicking,” “pitching” and any other unsettling or undesirable sounds as specified in these specifications
   iv. elimination of positive feedback for all stationary and mobile microphones used by the new PA system (if applicable)
   v. capable of accepting flexible controls, switch and volume adjustment tools for various PA zones
   vi. capable of implementation the contract specified priority scheme for various remote and local PA announcements

i. Contain an Ethernet interface module which allows for remote control and monitoring via 100 Mbs Ethernet and TCP/IP compliant to monitor equipment status via SNMP tools over the Caltrain LAN/WAN.

j. EIA 19-inch rack mountable

k. The pre-mixer/pre-amplifier shall be the BSS Audio, model BLU-160 or Engineer approved equal.

E. Local Paging Microphone/Handsets shall conform to the following:

   1. Possess the following features:
      a. Designed for Outdoor applications
      b. Physical design promotes noise canceling
      c. Rugged
      d. Push-to-talk switch
      e. Low-Impedance, Dynamic microphone

   2. Frequency Response: 100 Hz to 5 kHz
3. If required, housed in outdoor, stainless steel, NEMA 4X Latching, Hinged Cover, Microphone Enclosure by Hoffman A606CHNFSS or Engineer approved equal. The assembly shall incorporate female/male XLR connector terminations allowing disconnect and removal of the microphone and its cord out of enclosure.

3. The microphone shall be a Shure 577B or Engineer approved equal

F. Ambient Noise Sensing Microphones shall be dynamic, omni-directional, and conform to the following:

1. Frequency Response: 80 – 10,000 Hz
2. Low impedance, 150 ohms
3. Output Level: -61 dB
4. Weather resistant
5. Capable of being "phantom" powered (depending on the application)
6. The microphone shall be a Crown PZM11LLWRS1, a Bogen ANS500M (appropriately weather proofed), or Engineer approved equal.

G. PA cables shall:

1. Conform to the requirements Caltrain Standard Specifications 17120, Communications Wires and Cables, or Division 16, Electrical Sections.
2. The following models (or Engineer approved equals) are recommended:
   a. Speaker 4-Conductor Cable 14AWG: Belden model 6102UE for indoor installations and Belden model 5102UP for outdoor installations.
   b. Speaker 4-Conductor Cable 16AWG: Belden model 6202UE for indoor installations and Belden model 5202UP for outdoor installations.
   c. Microphone 2-pair Shielded Cable 18AWG: Belden model 6341PC for indoor installations and 5341PT for outdoor installations.

H. Protector Blocks:

1. Terminal Block Design: Protected terminal blocks shall be used for all copper cabling going to the outdoor equipment. All protector terminal blocks shall be assembled in manner, which allows for a 19 inch rack mount installation.
2. Protection Terminal Blocks: Protection shall be provided by Bourns 125-EW with Mounting Studs or Engineer approved equal.
I. AC Power Termination: Provide and install a disconnect switch assembly to terminate the incoming UPS AC power, and shall distribute power to the PA system components from this assembly.

J. Terminal Blocks:
1. Terminal block shall be provided and installed on the side panel for miscellaneous internal interconnections.
2. Brass binding posts shall be embedded in high impact polyurethane base.
3. Binding posts shall be equipped with two brass nuts and flat washers, sized to accept a minimum of two #12 AWG conductors.

K. Phone Access Device:
1. Furnish and install Telephone Line Powered Remote Access Device between the cell phone dial in line and the pre-mixer phone input. The device shall be installed in the existing telecom room and support the following features:
   a. Programmable 6 digit security code
   b. Two levels of access and programmable toll restriction
   c. Answers on the first ring. Disconnects on CPC, time out or by dialing #7
   d. Programmable 5 second to 50 minute call timer
   e. Wall mountable
   f. The Phone Access Device shall be a Viking, model RAD-1A or Engineer approved equal

L. Miscellaneous Equipment: Furnish and install the miscellaneous equipment necessary to complete the PA system. This shall include junction boxes, surface conduit between station junction boxes and PA devices, as well as miscellaneous mounting hardware and devices.

2.03 FACTORY ACCEPTANCE TESTS

A. Perform the tests based on the approved Test Procedures and Test Equipment. Demonstrate how the new PA system meets each design requirement of these specifications from the subpart 1.04 above. These tests shall include measurements of STI, coverage areas, sound pressure levels, input priorities implementation, noise filtering, feedback elimination, ambient noise sensing and automatic level control function, operation of the timed hang-up function, UPS/PA Alarm reporting, etc.

B. All equipment circuitry shall be checked for accuracy against the Contract Drawings. Tests shall verify point to point wiring and tags for proper nomenclature and terminal location.

C. All testing shall be witnessed, and, if successful, signed-off by the Contractor and the Engineer. If a test fails because of the Contractor improper execution, the Contractor shall fix and retest the failed or underperforming elements.
PART 3 – EXECUTION

3.01 INSTALLATION

A. Install equipment to comply with manufacturer’s written instructions, including taking measures to reduce noise, crosstalk, hum, and other audio quality issues.

B. If required, dismantle and remove the existing PA equipment as per design submittals (including the cutover phasing sequence) approved by the Engineer.

C. Install PA system as follows:

1. All PA equipment at the station
2. Ac power cable from station UPS power circuit breaker
3. Signal and station ground cable connection from stub-up at base of cabinet to disconnect switch assembly and ground busses
4. PA speakers and the Ambient Noise Sense microphone on the light standards and other structural members. Light standards used for speaker mounting must have an installed full-length divider to separate communication wiring from power wiring, or internal flex raceway for communication/PA wiring.
5. Conduit required to cable speakers to local PA equipment as required
6. PA cable from cabinet/rack to PA speakers, including necessary wiring and devices for noise sensing circuit(s)
7. Connections to, and termination of, all incoming telephone communications circuits from the Main Point of Entry (MPOE) cabinet
8. PA Equipment Network interfaces at Ethernet switches and PA digital I/O alarm wiring as required
9. Two Speakers in single mounting locations shall have ‘A’ and ‘B’ audio channels connected to the alternating speakers

D. Verify that all equipment is the appropriate model, properly installed and connected. The quality of the installation shall be demonstrated by tests for continuity, visual inspection and any other tests required by this Section.

E. Have all communications conduits inspected and cleaned prior to cable installation. Conduits shall have a clean, smooth concentric interior surface

F. Install PA cables in a separate conduit than those containing UTP data cable associated with other subsystems wherever possible.

G. Crossover of cables shall be avoided when cables are pulled into conduits. Care shall be taken not to have the conductors pulled tight or twisted in conduit fittings or boxes. All cables to be installed in a single conduit shall be pulled simultaneously.

H. Verify that all cables are properly routed, supported, terminated and labeled.
I. Verify that all equipment is installed in its proper location in accordance with the Engineer approved design. Verify that all mechanical connections are made and secure.

J. Wires and cables shall be continuous without splices between junction boxes, terminals, pull boxes, manholes and hand holes.

K. Provide protective covering for installed speakers and amplifiers until construction is complete. Prevent operation of amplifiers when covered.

L. Apply all IP addresses to the PA modules and Gateways as required by the Caltrain’s network standards and assigned by Caltrain Network Manager and recorded in the network Domain Name Server.

M. Configurations of the PA Mixer, Ambient Noise Compensator, and Output Amplifier shall be submitted electronically after final testing is completed.

N. Refer to Section 17060, Grounding of Communications Equipment, for grounding requirements.

3.02 FIELD QUALITY CONTROL

A. Perform the following field tests:

1. Functional tests of equipment for inputs at nominal Sound Pressure Level and STI measurements using STI-PA Female tone generators.

2. Correct phasing of all speakers

3. Noise level sensing and automatic broadcast level compensation

4. The functional tests shall fully exercise the system and determine functional compliance as follows:

   a. Perform end-to-end tests for every control and indication point

   b. Test all components and lines

5. Operational Test: Perform tests that include originating program and page material at microphone outlets, amplifier program inputs, and other inputs. Verify proper routing and volume levels and freedom from noise and distortion.

   a. Verify full functional communication between the assigned CCF and each of the existing stations

   b. Verify all features are available at each of the Control Consoles and they work as specified with the station

   c. Test and record the gain using a sound level meter at each speaker location and each mid-point between speakers along the platform under normal operation. Acceptable gain levels are between 3-15 dB
6. Signal-to-Noise Ratio Test: Measure the ratio of signal-to-noise of complete system at normal gain settings, using the following procedure:
   a. Disconnect a microphone at the connector or jack closest to it and replace it in the circuit with a signal generator using a 1,000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure the ratio of signal to noise.
   b. Repeat test for each separately controlled zone of loudspeakers
   c. Minimum acceptance ratio is 50 dB

7. Acoustic Coverage Test: Feed STI-PA Female tone generator into the system to measure STI levels at five locations in each zone and establish the SPL level for each zone. In addition, the SPL levels between locations in the same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.

8. Alarm testing of the speaker circuit loads: Disconnect the speakers at several points along each separate channel to insure that alarms levels are appropriately set and that alarms are sent by the equipment via the Ethernet interface and UPS Alarm Reporting.

9. Demonstrate the operation of programmed Day/Night time output level adjustment and input signal priorities.

10. Demonstrate the continued operation of the PA system during outside power outage.

11. STI Testing shall demonstrate the installed PA system outputs’ intelligibility as per the design.

12. Support Caltrain’s staff in testing announcements initiated by the CCF.

13. Retesting: Correct deficiencies, where necessary to optimize volume and uniformity of sound levels, and retest.

14. Schedule all tests with at least seven days advance notice to Engineer.

END OF SECTION
SECTION 17830
FARE COLLECTION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for the Ticket Vending Machines (TVMs) and for the Clipper Network Card Interface Devices (CIDs) as a subsystem of the station communications.

1.02 REFERENCE STANDARDS

A. Institute of Electrical and Electronics Engineers (IEEE):
   1. 802 Local and Metropolitan Area Network Standards
B. International Organization for Standard (ISO):
   1. 9001 Quality Management Standards
C. National Fire Protection Association (NFPA):
   1. 70 National Electric Code
D. Telecommunications Industry Association/Electronics Industries Alliance (TIA/EIA):
   1. 568-B Commercial Building Telecommunications Cabling Standard
E. Peripheral Component Interconnect (PCI)
   1. PCI Security Standards
F. Underwriters Laboratories, Inc. (UL):
   1. 444 Communications Cables
   2. 1863 Accessories Communications-Circuit

1.03 SYSTEM DESCRIPTION

A. The fare collection system consists of both the technical and administrative requirements for interfaces between the station Communications Equipment Room (CER), station Distribution Cabinets (DCs) and the station TVMs and CIDs. In absence of CER, some Caltrain stations may still utilize outdoor Station Communications Cabinets (SCC) also sometimes referred to as Communications Interface Cabinets (CIC). It is Caltrain’s intent to phase out the SCC’s/CIC’s and upgrade to the CER’s. Unless specifically required, in this document, for simplicity, the terms “SCC” and “CIC” are omitted; and the term “CER” is used instead as a universal substitute for these various types of station central Communications architecture.
B. Caltrain TVM Network System Description and Configuration:

1. Multiple TVM’s at each station are networked to a Caltrain TVM Virtual LAN (TVM VLAN) to consolidate data through the Distribution Cabinets (DCs) at the CER Caltrain LAN.

2. Dual Caltrain Ethernet switches’ ports at DCs and the CER shall be provisioned at 100 Mbps for a separate Caltrain TVM Virtual Local Area Network (TVM VLAN) to segregate this traffic from all others on the network. Also, the SNMP monitoring is to be established for monitoring the SNMP capable Caltrain Network devices (i.e. Switches, UPS, PA, etc.)

3. The Station TVM VLAN shall have existing connectivity to the Caltrain WAN/LAN and subsequently to a Fare Collection Data Storage Computer (DSC) located at Caltrain Headquarters in San Carlos. If the station Private Virtual Circuit (PVC) is not established, the Contractor shall assist Caltrain with enabling and programming of such PVC to enable Caltrain WAN/LAN connection. This connectivity shall allow data to be exchanged between individual Station TVMs and the Data Storage Computers. The TVM VLAN shall always be assigned to the highest priority among other station VLANs dedicated to all other remaining subsystems at the Caltrain station LAN. This shall be done to ensure other subsystems’ communications could not interfere with the passage of information between the Caltrain station Fare Collection equipment and the Caltrain DSC.

4. The station TVM shall be a direct 10/100 Mbps Ethernet connection to its assigned Caltrain network switch. For redundancy, where multiple TVMs are assigned to the Caltrain dual Ethernet Switches at the same location (DC or CER), the TVMs shall be divided into two equal groups. The first group shall be assigned to the first switch ports and the second group shall be assigned to the second redundant switch ports. If a TVM design provides for dual network connectivity, connect first TVM port to the port at the first switch and connect the second TVM port to the port at the second switch.

5. The station fiber optic backbone ring (used by TVM VLAN) shall be physically diverse using dedicated fiber optic cable and raceway. Connectivity between the TVM and its assigned distribution switch shall be made with Category 6 UTP cable.

6. In the event that the cable distance from the distribution switch is greater than 300 feet, a single-mode fiber optic cable and the corresponding media converters shall be used to provide the necessary Ethernet connectivity.

7. All TVMs and the communications equipment for the TVM operations shall utilize UPS-backed power. The UPS shall be rated to ensure TVM uninterrupted service for at least 90 min (in case of loss of station utility power).

8. TVM VLAN communications utilizes Caltrain station LAN networking devices and Caltrain station physical fiber-optic backbone. To ensure
fare collection transactions are never interrupted or lost as a result of the updates to the station infrastructure; or any activities, which may involve changes to the station LAN networking devices, racks and cabling; and Caltrain station physical fiber-optic backbone, shall be done during non-revenue hours. Prior to commencing such activities, the Contractor shall submit for approval to the Engineer the description of activities, affected equipment, cutover, testing and fallback procedures. After completion of these activities, all Caltrain station TVM’s functionality shall be verified, tested and witnessed (at the station and at the DSC headend) by the designated Caltrain personnel. See also Section 17000, Basic Communications Technical Requirements, for related and additional submittal requirements.

C. Clipper Card Interface Devices (CIDs) Network System Description and Configuration:

1. Clipper is a regional fare collection system that is designed and administered by the San Francisco Bay Area Metropolitan Transportation Commission (MTC). Multiple CIDs at each station are networked to a Clipper LAN (CID LAN) to consolidate data through the Distribution Cabinets (DCs) at the CER Clipper CID WAN/LAN.

2. The Clipper Contractor (working under MTC) provides for a separate Wide Area Network connection (at MPOE) between Clipper Network WAN and the station CID LAN.

3. CID Ethernet switches are separate from Caltrain dual Ethernet Switches. CID LAN is typically non-redundant and implemented as traditional star topology LAN utilizing 1Gbps fiber-optic backbone connections between the CER and DC switches.

4. CID Ethernet Switches’ ports at DCs and the CER are provisioned at 100 Mbps for a CID Local Area Network (CID LAN).

5. Even though CID LAN network devices share Caltrain station physical fiber backbone cabling (and fiber-optic and CAT6 patch panel equipment), CID station LAN and Caltrain LAN network devices are physically segregated to avoid any type of communications interface between these two LANs.

6. The CID LAN Network devices are furnished and programmed by the Clipper Contractor. This includes CID Router, CER CID Ethernet Switch, DC CID Ethernet Switches and actual CID card readers to be installed at the CID poles.

7. Caltrain furnishes CID poles and CID poles temporary covers. The Clipper Contractor is responsible for their installation.

8. The Clipper Contractor is also responsible for provision and installation of all remaining station equipment serving CID equipment, such as: rack space; junction boxes, all interconnecting conduits and comm/power wiring; and provision, installation and termination of all necessary 24VDC
power supplies in DC cabinets (one power supply per two CID devices), etc.

8. Clipper Card Interface Devices (CIDs) are typically installed near the station TVM shelters.

9. The CIDs are powered by 24VDC power from the station Distribution Cabinets. The corresponding 24VDC Power Supplies shall be powered by the UPS-backed power. The UPS shall be rated to ensure TVM uninterrupted service for at least 90 min (in case of loss of station utility power).

10. The CIDs communications cabling shall be Cat 6 cables or Single-Mode fiber cables from the associated CID Ethernet switch. The CID communications and power cables shall be routed within the same Communications conduits.

11. Clipper LAN communications utilizes Caltrain station LAN networking patch-panel equipment, racks and Caltrain station physical fiber-optic backbone. To ensure CID transactions are never interrupted or lost as a result of the updates to the station infrastructure; or any activities, which may involve changes to the mentioned above station LAN equipment, shall be done during non-revenue hours. Prior to commencing such activities, the Clipper Contractor shall submit to the Engineer for approval the description of activities, affected equipment, cutover, testing and fallback procedures. After completion of these activities, all Caltrain station CID’s functionality shall be verified, tested and witnessed (at the station and at the Clipper headend) by Caltrain and Clipper personnel. See also Section 17000, Basic Communications Technical Requirements, for related and additional submittal requirements.

1.04 SUBMITTALS

A. Refer to Section 17000, Basic Communications Technical Requirements, for related and additional submittal requirements.

B. Preliminary Design Technical (PDT) Requirements:

1. Complete product data including description and model number, shop drawings, catalog cuts and technical literature for the following equipment and material:

   a. Data switch
   b. Fiber and copper interconnection equipment
   c. Media conversion equipment (if applicable)
   d. Cable

2. Fare Collection (TVM and CID) LANs logic diagram and overall system description.
3. Interface description between the TVM VLAN and other Communications subsystems required to complete the transfer of Caltrain Fare Collection data from TVMs to DSC.

4. Proposed Ethernet switch operating software with descriptive documentation, including, but not limited to:
   a. Release Notes
   b. Product Bulletins
   c. Applicable Field Notices
   d. Design Guides

5. Equipment operating instructions or details

6. Mounting and installation details, rack layouts

7. Complete End-to-End wiring diagrams

8. Inside Plant (ISP) and Outside Plant (OSP) cable routing, pair, and fiber strand usage diagrams

9. Intra and Inter rack wiring

10. Patches

11. Power and grounding

C. Final Design Technical (FDT) Requirements: Include the following information as part of the Final Design submittal package for the Fare Collection equipment:

1. Updated PDR information. All drawings, calculations and design information shall reflect a final design.

2. Fiber optic link loss budgets for all fiber optic spans between the CER and the Fare Collection network devices sufficient to show that all proposed spans meet published link loss budgets.

D. Installation Work Plans: Submit the following installation document for each site prior to the scheduled installation activities. The Installation Work plan shall include:

1. Drawings showing plan and elevation details of equipment including conduit interface

2. Cable and wire requirements

3. Grounding details

E. Calculations or Certifications: Submit fiber span loss calculations (as required in the Design Review Sections) to validate switch distances.
F. Product Samples: Submit and demonstrate product samples when requested by the Engineer.

G. Cutover Plan and Test Plan and Procedures. To ensure Fare Collection transactions are never interrupted or lost as a result of the testing, cutover or installations; any activities, which may potentially affect the station TVM VLAN / CID LAN and/or related equipment, shall be done during non-revenue hours.

1. Test Program Plan: Include all the required information for the Fare Collection equipment in the Test Program Plan as outlined in these Specifications including routing, network paths, device and software functions (i.e. programmable alarm and SNMP settings), which shall include testing equipment required; any Caltrain, Clipper and/or Contractor personnel required (including their locations); tested functions, test sequence and pass/fail criteria. All elements/functions, which failed as a result of Contractor’s errors shall be corrected.

2. Factory and Inspection Test Procedure: Submit a complete factory test and inspection procedure to satisfy all the requirements outlined under “Source Quality Control” in this Section.

3. Field Test Procedure: Submit a complete field test procedure to satisfy all the requirements outlined under “Testing and Inspection” in this Section.

4. Cutover Test Plan: Submit for approval to the Engineer the description of activities, all affected subsystems and equipment, cutover sequence, successful cutover variation criteria and fallback plan/procedures.

5. End-to-End Acceptance Test: End-to-End Test shall be performed for all communication wiring between CID Router and all CID Switches; all power and communication wiring (including fiber, if applicable) between CID switches in DCs and CID poles at station.

6. System Integration Test (SIT): Provide qualified personnel to support the Fare Collection integration test as described under “Testing” in this Section. The Engineer will direct the SIT.

H. Test Records: Submit the Test Records for review one week after the completion of each test in accordance with 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 and drawings, as specified in Section 17000, Basic Communications Technical Requirements, and the following requirements.

1. Include complete equipment data with operating instructions.
2. Accompanying each interface drawings package shall be a written interface specification that details the functional, electrical and mechanical interface properties.

3. Default or As-built Configuration and Provisioning Information for each programmable piece of equipment to allow system integration by follow-on contractors and consultants, including:
   a. Programming passwords
   b. Programmable feature settings
   c. Board level switch/strap settings
   d. Node addressing information
   e. Programmable alarm and SNMP settings

4. Card layout or slot configurations (component equipment inventory).

5. Any other configuration or provisioning which deviates from manufacturer’s default state.

1.05 QUALITY ASSURANCE

A. Applicable Standards and Codes: Design, fabrication, inspection, installation and testing shall comply with all applicable Standards and Codes as listed herein. All equipment and methods shall comply with the standards listed under Reference Standards herein.

B. Material and Workmanship Requirements:
   1. All equipment provided under this Section shall be UL listed.
   2. All products specified herein shall be subject to the Engineer’s approval based on the Contractor’s ability to demonstrate adherence to these Specifications and Engineer’s approval of the manufacturer’s quality process.
   3. All products shall be compatible with existing WAN and DSC elements in order to perform the intended use set forth by the Engineer. WAN and DSC elements are networking components to connect the station to the CCF or other remote monitoring and control locations.
   4. Use no discontinued or end-of-life product models, refurbished equipment, or products scheduled for end-of-life, end-of-sale, or end-of-service within one calendar year of the installation date.

PART 2 - PRODUCTS

2.01 FARE COLLECTION MATERIALS AND EQUIPMENT

A. Owner-furnished materials and equipment: Ticket Vending Machines (TVMs), TVM pedestals, Card Interface Device (CID) Poles and Poles’ temporary covers.
B. Clipper Contractor furnishes, installs and performs the required programming the WAN/LAN Connection, CID Router, CER CID Ethernet Switch, DC’s CID Ethernet Switches and actual CID card readers (to be installed at the CID poles). TVM and CID equipment quantities vary with each project (see the Contract documents for the specific project quantities).

C. Install TVM Pedestals, CID poles and CID poles temporary covers and the associated grounding equipment.

D. Provide and install of all remaining station equipment serving station TVM and CID equipment, such as: rack space; all interconnecting conduits and comm/power/grounding wiring (power conductors, Category 6 or fiber optic cable as indicated on the Contract Drawings); and provision, installation and termination of all necessary CID 24VDC power supplies in DC cabinets (one power supply per two CID devices), etc.

E. Provide TVM LAN field fiber-to-copper media converter/switch (if applicable).

F. Provide Caltrain switch and TVM IP address, subnet, and default gateway. Establish highest priority for TVM VLAN. Assist Clipper Contractor personnel with programming and testing of CID network devices.


H. Provide, install, and test all TVM Fare Collection software applications from the Caltrain’s Headquarters Fare Collection Network.

2.02 CALTRAIN DATA SWITCH

A. All network equipment shall come with the latest secure IOS image supporting SSH, cryptomap, etc.

B. All network equipment shall be PCI compliant.

C. TVM VLAN shall utilize TCP/IP as the transport and network layer service protocol. Physical Ethernet interface settings shall be set to 100 Mbps, Full Duplex.

D. TVM VLAN shall utilize the Caltrain dual redundant Ethernet switches placed within CER and DCs as shown in the Contract documents.

E. CID LAN shall utilize the Clipper Router and Ethernet switches placed within CER and DCs as shown in the Contract documents.

2.03 SOURCE QUALITY CONTROL – FACTORY TESTING AND INSPECTION

A. Notify the Engineer in writing at least 10 days prior to each scheduled test.

B. Conduct Factory Testing on individual equipment or assembled subsystems after all mounting, installation, wiring and other activities to support turn-up are complete.
C. Perform diagnostic testing for all equipment and all communications ports.

D. Perform functional testing and validation of equipment settings on all equipment.

E. Any commercial off-the-shelf equipment that shares a common interface shall be assembled, integrated, and factory tested for compatibility.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment shall be installed as shown in the Contract Drawings, and in accordance with the manufacturer’s recommendations.

B. Install data transmission equipment, media conversion (if applicable), and interconnection equipment at the CER or DC to each TVM or CID per the Contract Drawings. Install 24VDC power wiring for the CIDs per the Contract Drawings.

C. Coordinate closely all Work described in this Section with the Engineer of the Fare Collection Vendor.

D. Coordinate details of all interface requirements with the Engineer and be responsible for End-to-End testing.

E. Coordinate all civil Work and installation of all facilities, equipment and cables with the Engineer.

F. Cables and Wiring:

1. Provide copper or fiber optic cable from each TVM and CID routing through assigned conduits to networking equipment located in the CER or Distribution Cabinets per the Contract Drawings. Terminate and test all fiber optic strands or copper pairs (including 24VDC power wiring for CID’s), whether assigned working or spare (dark).

2. Provide a Fiber Distribution Panel (FDP), Fiber Slack Enclosures, fiber patch cords, SC-type connectors; splice trays, and other components for a complete structured cable system in accordance with these Specifications.

3. Provide proper Category 6 UTP cable termination hardware and circuit protection in accordance with these Specifications.

4. Install UPS electrical power from assigned UPS distribution panels to each TVM and CID Power Supplies per the Contract Drawings. Ensure proper grounding and lightning/surge protection for all TVM and CID equipment installations.

5. Prior to TVM or CID installation, seal and protect exposed ends of power and signal cables, and coil at least 12 feet of service length in the TVM junction box or pull-box for future termination or at the top of the CID Pole and the Pole Temporary Cover.
G. TVM and CID equipment quantities and locations shall be in accordance with the Contract Drawings.

3.02 TESTING AND INSPECTION

A. Perform the following inspection and test on the Fare Collection equipment at each installed location. Notify the Engineer in writing at least 10 days prior to each scheduled test. Any testing, which may potentially disrupt or hinder the performance of the operational Fare Collection equipment shall be performed during non-revenue hours.

B. Factory Test and Inspection: See Source Quality Control herein.

C. Field Inspection: Field inspection of the Fare Collection equipment shall verify the following:

1. Equipment damage in transit  
2. Equipment, port, and cable labeling  
3. Power supply integration and mounting  
4. Cable routing  
5. Unobstructed air flow to vented equipment

D. Field Test: The following tests shall be performed in the presence of the Engineer:

1. Functional testing from each TVM to the Data Switch interface. If required, utilize a data test set at the demarcation point to validate connection, TVM VLAN priority and data transfer from each TVM.

2. Failover testing (for TVM equipped with local switching and ring protection): Disconnect one side of dual port field media converter/switch and ensure TVM maintains networking. Restore connections and remove opposite path fiber ports and repeat testing.

3. Verify power connections and grounding for proper gauges, continuity, ground resistance/faults, acceptable voltage levels, cross-talk, etc., test and record the results.

4. Test all fiber or copper distribution cabling per TIA/EIA 568-B standards.

E. End-to-End Acceptance Test: Test all communication, power and grounding wiring for station CID equipment.

F. Cutover Testing: Cutover activities shall be performed during non-revenue hours only. If failed, the Cutover shall be repeated only when the problem(s) is discovered and fixed.

1. Data Cable tests: Prior to cutover testing, all data cable shall first be tested. The test results shall be submitted 2 weeks prior to cutover date
to the Engineer for review and approval. Do not begin cutover without the Engineer’s approval of the data cable test results.

2. Ensure all functional testing for each TVM was successful.

3. Disconnect the existing station Caltrain WAN/LAN Router from the leased line and connect the CER dual switches to the new station Caltrain WAN/LAN router and communications equipment.

4. Conduct System Integration Test (see below) and verify the updated communications for the involved devices (including Caltrain TVM’s)

G. System Integration Test: Provide sufficient technical staff to support the following testing activities during the Owner’s systems integration test.

1. Full path Ethernet connectivity testing between TVMs and Fare Collection DSC.

2. Functional end-to-end testing between Fare Collection DSC and each networked TVM.

3. TVM intrusion alarm operation and reporting.

4. Assist Clipper Contractor personnel with the CID equipment testing and troubleshooting.

5. Conduct TVM and CID testing in the event of updates to the station infrastructure or any other activities, which involve changes to the station networking equipment, which may potentially affect performance of the TVM or CID equipment.

END OF SECTION
SECTION 17850
CLOSED CIRCUIT TELEVISION CAMERA (CCTV) SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for the Closed Circuit Television Camera (CCTV) System and associated Local Area Network (LAN) as a subsystem of Caltrain station communications. These requirements are for standard Caltrain station video surveillance applications. For other applications (i.e. maintenance facilities, tunnels, bridges, infrared/wireless CCTV, etc.) refer to the corresponding project additional specific requirements.

B. Coordinate and provide interfaces between the station Communications Equipment Room (CER) and the station CCTV subsystem. Note that, in absence of CER, some Caltrain stations may still utilize outdoor Station Communications Cabinets (SCC) also sometimes referred to as Communications Interface Cabinets (CIC). In the future, SCC’s/CIC’s will be phased out and upgraded to CER’s. In these specifications, for simplicity, the terms “SCC” and “CIC” are omitted. The term “CER” is used instead and it covers all types of station central Communications equipment implementation.

C. The design (from concept to final stage), installation and acceptance shall follow CPTED (Crime Prevention Through Environmental Design) guidelines. The design, installation, testing and acceptance shall be approved and witnessed by CPTED certified personnel and Caltrain.

1.02 REFERENCED STANDARDS

A. Electronic Industries Association (EIA):
   1. Standards 170, 232, 250C and 485

B. Federal Communications Commission (FCC):

C. International Standards Organization (ISO):
   1. 9001 Quality Management Systems - Requirements

D. Military Standards (MIL-STD)
   1. 454 Standard General Requirements for Electronic Equipment
      2. 810E Method 509 Procedure 1 – exterior salt atmospheres

E. National Fire Protection Association (NFPA):
   1. 70 National Electric Code (NEC)
F. National Electrical Manufacturers Association (NEMA)

G. Institute of Electrical and Electronics Engineers (IEEE)

D. Department of Homeland Security (DHS)

1.03 SYSTEM DESCRIPTION AND CONFIGURATION

A. Closed Circuit Television Cameras (CCTVs) at each passenger station shall be connected into the Station LAN to consolidate data at the Communications Equipment Room (CER) via a 100/1000 Mbps multi-port redundant Ethernet Station LAN switches.

B. Redundant Ethernet switch ports at the CER are provisioned at least 100 Mbps for a separate CCTV Virtual Local Area Network (VLAN) to segregate the CCTV traffic from all others on the network.

C. The station CCTV VLAN shall share the station LAN 1000 Mbps Ethernet backbone bandwidth with other station subsystems. The station LAN 1000 Mbps backbone will operate in a physical ring topology via the station single-mode fiber optic cable.

D. Depending on the cabling distance, each station CCTV location shall be directly connected to its assigned network switch using dedicated either copper (Category 6) or fiber optic cable and raceway.

E. CCTV cameras requiring Power over Ethernet (PoE) shall utilize Cat 6 cable. The Distribution Cabinet redundant Ethernet Switches shall either incorporate PoE capable Ethernet ports or utilize external PoE power injectors. The external power injectors shall be used only for locations where the Ethernet switches are existing and do not incorporate PoE capable ports functionality.

F. At field locations where the VMS (visual message sign system) occupy the same pole as the CCTV, separate raceway will be used for each subsystem.

G. CCTV cameras connections shall be equally distributed between two redundant switches/rings. When available, CCTV cameras with integrated network switching and route protection capabilities shall be provided dual copper or fiber cable connectivity for maximum network redundancy.

H. All station cameras will use TCP/IP protocol. Digital video recorders, mobile computer, and motion detection software will be housed in the station CER.

I. Products specified herein will cover digital (IP) cameras. The design preference of choice for new construction is an IP video camera to reduce cabling, electronic components, and power consumption. Whenever cabling distances allow, IP cameras shall operate Power-over-Ethernet (PoE) IEEE 802.3af.

J. The station CCTV system components shall be compatible with the Caltrain existing CCTV headend in Caltrain headquarters in San Carlos provided by Verint Nextiva. The modifications to the existing Caltrain headend will be performed by Caltrain. The Contractor shall facilitate integration of the new station CCTV equipment into the existing CCTV headend and coordinate with Caltrain on the
design, implementation and testing details of the new equipment affecting the existing system.

1.04 DETAILED WORK SCOPE

A. This work includes installing field CCTV assemblies consisting of camera, zoom lens, pan/tilt drive, power supply and standard or dome enclosure. Work scope includes furnishing and installation of CCTV assembly, cabling, network electronics, and CCTV interface panel and the station Digital Video Recorder (DVR). The work also includes furnishing and installing communication interface for fiber optic and data cable. Camera assembly shall include all necessary for proper operations pole or surface mounting and attachment hardware and electrical cabling and connections.

B. The CCTV camera system shall include, but not be limited to, the following components and features:

1. CCTV camera with auto focus zoom lens at a mounting height above the platform or station surface as detailed in the Contract drawings.

2. The CCTV Camera assembly and/or mounting hardware shall allow for the specified pan and tilt.

3. Standard or dome, watertight environmental housing, and, if required by design, capable of being pressurized.

4. Mounting hardware with no exposed camera control or power wiring.

5. CCTV camera pole with or without the use of a lowering device, with a pole height above the platform surface as detailed in the site specific drawings (stand-alone CCTV camera poles are typically used only if the existing station structures cannot be utilized).

6. Site data/power cabling for IP cameras.

7. Camera control electronics and equipment (i.e., hardware and software).

8. CCTV assembly with azimuth and labeling capabilities.

9. Power, and data/video cables for external power supplies (if required), images, and camera controls.

10. Transient voltage suppression and surge/lightning protection.

11. Network communication cables.

12. Power over Ethernet injectors as required by the camera locations and design.

13. Indication of the blank out or privacy zone positions using text messages on the video display.

15. Video processing, storage and display equipment.

16. Any and all ancillary equipment required for a fully operational, shared surveillance system.

17. NTCIP compatible driver.

18. 4-wire 422 interface, if applicable.

19. Text labeling on video display.

1.05 SUBMITTALS

A. Refer to Section 17000, Basic Communications Technical Requirements, for related and additional submittal requirements.

B. Submit detailed catalog data for all equipment and materials, including accessories.

C. If proposed CCTV mounting is not an off-the-shelf item or was not originally designed to be used for the proposed mounting arrangement, submit structural design, including drawings and calculations, signed and sealed by a Structural Engineer licensed in the state of California.

D. With each Design Review level, submit the updated CCTV coverage map. The CCTV coverage map shall identify for each camera: camera type and model; mounting elevation; tilt; direction of coverage, radius of coverage; horizontal and, where necessary, vertical angles of view. Coordinate with Caltrain the desired level of detail (pixel per foot) requirements for each camera. Typical high priority targets require camera resolution of more than 40 pixels per foot (forensic level of details); the remaining areas typically require at least 20 pixels per foot (general level of details).

E. With each Design Review level, submit the proposed WAN/LAN/VLAN IP addressing scheme and security scheme for all new CCTV elements to match the addressing scheme and security scheme of the existing Caltrain CCTV headend.

F. Submit installation drawings no later than 14 days prior to installation of the CCTV system. Include description of modifications and the cutover sequence for incorporating of the new CCTV equipment into the existing Caltrain CCTV system and fall-back procedures (in case something goes wrong). Proceed with the installation only after the Engineer approval of installation submittal.

G. Testing: Conduct local station CCTV testing to verify each camera’s settings and coverage details as per the approved Design Submittals. After the successful local testing and the cutover to the existing CCTV headend, assist Caltrain personnel with integrated headend/field CCTV system testing. All tests shall be done as per the approved test procedures and witnessed/signed-off by the Contractor and Caltrain. Prior to signing off a tested equipment/function; if found, each issue in the Contractor’s scope of work shall be corrected by the
Contractor and retested prior to final acceptance by Caltrain. Submit, within 15 days after conclusion of system testing, a report of final Test Procedures and the Results obtained from these tests.

H. As-Built Documentation: Submit complete As-Built documentation and drawings, as specified in Section 17000, Basic Communications Technical Requirements, for equipment. Also, the As-Built documentation shall contain the asbuilt CCTV System coverage areas, the station CCTV equipment final LAN/WAN and Software configuration settings.

I. Operation and Maintenance Data: Provide documentation containing complete details of the delivered equipment including operating and maintenance procedures and manuals.

PART 2 - PRODUCTS

2.01 GENERAL

A. Typical Station CCTV System Components:

1. Integrated camera assembly: Depending on each camera type, it may include following elements: camera, lens, housing, pan-tilt drive unit, infrared illuminator, fan/heater/blower, fiber transceiver, power supply, mounting brackets and other mounting hardware.

Some CCTV Camera manufacturers provide for complete “all-in-one” camera assemblies, where all elements are already included and match (do not require separate design and manual labor for the assembly) and include all necessary equipment for mounting and termination. These types of CCTV assemblies provide significant saving for the project by simplifying the design and reducing the amount of labor.

CCTV camera assemblies are typically made specifically for either outdoors or indoor applications. Some vendors, however, produce universal types of camera assemblies, which may be used for either environment.

2. An integrated camera assembly is connected (via the associated conduits) to the closest point of service, which is typically the closest redundant Ethernet switch located at either the nearby Distribution Cabinet (DC) or Communication Equipment Room (CER). Typically PoE is used for powering the camera assemblies.

For remote locations, a fiber optic cabling is used, which requires the camera assembly to incorporate a fiber transceiver and for the designers to identify local sources of power. Where installation of the fiber cabling is problematic, a wireless link maybe considered for the remote sites. Implementation of the wireless links; however, is not recommended (due to numerous challenges of the transit environment) and shall be considered as a last option resort.

3. A rack-mounted Station CCTV DVR equipment with all necessary hardware and software configured to communicate with the Caltrain
existing headend. The station DVR equipment shall be mounted into either the dedicated rack within CER; or dedicated standalone rack in telecommunication closet.

4. All other materials necessary for installation of the CCTV and other cabinets and camera assembly (including materials required to interface the CCTV camera assembly to the electrical power) as required.

2.02 INTEGRATED IP FIXED CAMERA ASSEMBLY

A. Product Description:

1. The specified product shall be a high-resolution Day/Night network camera integrated into an all-weather NEMA 4/IP66 rated enclosure designed for both indoor and outdoor applications. The integrated camera is an industrial grade, color, and full-featured, day/night 5.0 megapixel network camera.

The unit consists of 1) a camera and lens module, 2) a wall, ceiling, and parapet arm, and 3) a power/data back box. The camera shall be powered via the Ethernet (Power-Over-Ethernet) using an IEEE 802.3af power source or may be powered directly via 12-24VDC or 24VAC.

The product shall be designed to meet or exceed industrial and surveillance applications requiring a low power, rugged video camera with IP network capability. The camera shall have a built-in web server and FTP server.

B. General Product Requirements:

1. The specified product shall be a high-resolution, Day/Night ½-inch optical format, network camera integrated into an all-weather NEMA 4/IP66 rated enclosure designed for both indoor and outdoor applications.

2. The operating temperature range shall be -22 deg F to +122 deg F.

3. The integrated camera shall be an industrial grade, color, and full-featured, Day/Night 5.0 megapixel network camera with ½-inch optical format.

4. The camera shall be powered via the Ethernet (Power-Over-Ethernet) using an IEEE 802.3af power source or powered directly via 12-24VDC or 24VAC.

5. The power/data back box shall allow entry of cables from the rear of the box that pass through two ½-inch Heyco watertight fittings. A ½-inch NPT mount shall also be available at the bottom of the box to accommodate cables or conduit.

6. The back box shall be supplied with arm hangers to hold the camera/arm module in place on the back box during wall, ceiling, or parapet mounting installation.
7. The back box shall provide both input and output alarm trigger connections.

8. The camera unit shall have a pivoting arm to allow the product to be wall, ceiling, or parapet mounted without requiring any additional hardware.

9. The camera housing shall be 360 deg adjustable in the pan direction and 180 deg in the tilt direction.

10. The camera shall be vandal and tamper-resistant.

11. The product shall be available with any of the following lenses:
    a. 4-12 mm, f1.4, ½-inch CS format, wide varifocal IR corrected lens
    b. 12-40 mm f1.4, ½-inch CS format, telephoto varifocal IR corrected lens
    c. 1.8-3 mm, f1.8, ½-inch CS format, ultra wide varifocal IR corrected lens

12. To simplify lens setup during installation, an analog output for a display monitor shall be accessible when the lens housing is separated from the camera housing.

13. A mechanical reset button shall be available in the back box to return the camera to the factory default setup.

C. Camera Specifications:

1. The Day/Night high-resolution color camera specified shall incorporate a progressive scan CMOS imager with a 1/2-inch optical format, not less than 5.0 million megapixels and shall have a dichroic infrared mirror.

2. The image resolution shall be minimum 2560(H) x 1920(V) pixels. The camera’s aspect ratio (horizontal vs. vertical lines) shall be user configurable and not limited to only 4:3 or 9:6 aspect ratios.

3. The camera shall produce 10 frames per second (fps) at full 2560(H) x 1920(V) resolution. The maximum frame rates are 10fps at 4:3 aspect ratio and 13fps at 16:9 aspect ratio.

4. Minimum light requirement to produce a color image shall be approximately 0.30 lux (0.03 fc) with a f1.2 lens. When in the IR sensitive Night mode, less than 0.05 lux (.005 fc) will produce a black and white image.

5. The camera shall provide automatic white balance, automatic exposure, gain control, electronic shutter, and backlight compensation. It shall use MJPEG (and MPEG-4/H.264, if available) video-compression. The images can be viewed via a standard browser.
6. A night mode feature, shall slow the shutter speed down to enhance the nighttime sensitivity of the camera.

7. The camera shall have on-camera storage. Provide for a minimum 32GB card for on-camera storage purposes.

8. Digital image authentication shall be optionally available and licensed to verify that images have not been altered, manipulated, or tampered with, in any way.

9. The camera shall provide on-screen time/date and text displays. The text display can be programmed to dynamically change when motion alarms are detected.

10. The camera shall provide built-in motion detection allowing up to eight separate, rectangular motion windows (zones) to be independently configured. Each window may have its interior pixels included or excluded from consideration by the motion detection algorithm. Windows configured to have pixels included in the motion calculations shall allow the threshold of both the sensitivity (pixel values) and size (quantity of pixels) to be set.

11. The camera shall provide on-screen, digital, pan/tilt/zoom on live or recorded video.

12. Provide User and Administrator password protection levels.

13. Up to eight (8) rectangular privacy windows may be configured to mask out specific video from view in the image.

14. The camera shall capture image sequences by time lapse intervals or trigger events and transfer the jpeg images via FTP and/or e-mail.

15. Specialized software that enables multiple users to receive alerts via a pop-up window when the camera receives an internal or external trigger shall be available via an optional license upgrade.

D. Camera Networking Requirements:


2. Camera functionality shall be available to users running versions of Java VM and web-browser applications released after January 1, 2004.

3. The camera shall provide integrated support for IP, TCP, UDP, ICMP, ARP, FTP, SMTP, DHCP, HTTP, RARP, BOOTP, SNMP, Telnet, and TFTP protocols.

4. The camera shall provide a multiview function where a single browser page shall be capable of displaying streaming images from up to nine cameras simultaneously.
5. No unique or proprietary client software shall be required for viewing or controlling the camera.

6. The camera shall be user configurable and the administrator may functionally or aesthetically modify the camera’s web pages.

7. The camera shall provide for up to 64 area-of-interest streams that can be independently created of any size and aspect ratio and with any desired display resolution. Substream frame rate can also be configured, up to the maximum frame rate delivered by the camera.

8. The camera shall offer a web interface for quick creation of up to three substream windows with auto-port configuration of each stream.

E. Camera Recording/Playback Requirements:

1. The manufacturer shall offer optional, licensable embedded recording/playback software that allows images to be recorded to an external FTP server.

2. Images may be stored at a fixed periodic record rate and/or when triggered by motion and/or external input. Playback shall allow all images recorded to be viewed forward or backward in time.

3. The camera shall record all images in a proprietary file format.

4. The camera shall include pre-event and post-event recording, time-date search, JPEG snapshot, and AVI export functionality.

F. Event (Alarm) Handling Capability:

1. The camera shall be capable of recording an event as pre and post event images. The camera shall also be able to transfer the event’s JPEG images to an FTP server via File Transfer Protocol (FTP). Events may be triggered using camera motion detection or from an external device input such as a relay.

2. When triggered from an external input or the camera’s motion detector, the camera shall be capable of sending JPEG images via e-mail and/or sequences of images to an FTP server.

3. A relay output shall be available upon the activation of the camera’s motion detector or external relay input. The relay output may also be manually activated from the live view screen.

G. Back box Connections:

1. RJ-45 Ethernet connector (IEEE 802.3af PoE compliant)

2. Punch Down terminal for CAT5, CAT5e, or CAT6 cable
3. Screw terminal: Direct power for 12-24VDC or 24VAC, Trigger In and Trigger Out

H. Electrical Specifications:
1. Power Consumption: 6 watts maximum
2. Power requirement: 12-24VDC or 24VAC or via IEEE 802.3af Power-over-Ethernet on CAT5, CAT5e, or CAT6 cable

I. Mechanical Specifications:
1. Weight (without lens): 96oz (2839g)
2. Dimensions: 15.36 L x 5.18 W x 9.58 H inches
3. Lens: As required by the application
4. The camera shall feature solid-state components to resist shock and vibration and have no moving parts

J. Environmental Specifications:
1. Temperature range: -22 deg. F to +122 deg. F
2. Environmental Enclosure rating: IP66/NEMA 4

K. Certifications and Approvals:
1. Electromagnetic Compatibility
   a. Emissions:
      i. FCC, Class A part 15
      iv. AS/NZS CISPR 22:2002; Class A
   b. Immunity:
2. Safety:
   a. EN 60950-1:2001 with A11:2004
   b. IEC 60950-1:2001
3. Restriction of Hazardous Substance (RoHS): All material and/or components used in the manufacture of the product shall be in compliance with the EU Directive 2002/95/EC RoHS.

L. IP camera assembly shall be IQinVision model IQeye Sentinel Series, IQeye855v7 or Caltrain approved equal.

2.03 INTEGRATED DOME IP CAMERA ASSEMBLY

A. Product Description:

1. The product specified shall be an all-in-one vandal/tamper resistant 5.0 megapixel resolution color dome camera designed for indoor/outdoor applications providing multiple H.264 (MPEG4, Part 10) and simultaneous MJPEG streams that can be individually configured. The dome camera shall provide 10fps at maximum resolution with audio, and shall conform to the ONVIF and PSIA standards.

2. The camera shall provide for Day/Night functionality with high sensitivity for use in low light indoor/outdoor applications, and is prepackaged with a varifocal IR corrected lens to allow manual zoom and focus adjustment.

3. The dome camera shall be constructed of cast-aluminum housing with polycarbonate dome bubble and auto tracking inner liner. The dome camera shall be designed to protect against water and dust to IP66 / NEMA 4 standards; require low power the dome camera such as PoE (IEEE 802.3af) compliant, or direct power by 12-24VDC or 24VAC.

B. General Product Requirements:

1. The specified product shall be a high-resolution, Day/Night ½-inch optical format, network camera integrated into an all-weather NEMA 4 / IP66 rated enclosure designed for both indoor and outdoor applications.

2. The operating temperature range shall be -22 deg F to +122 deg F.

3. The integrated camera shall be an industrial grade, color, and full-featured, Day/Night 5.0 megapixel network camera with ½-inch optical format.

4. The camera shall be powered via the Ethernet (Power-Over-Ethernet) using an IEEE 802.3af power source or, if necessary, powered directly via 12-24VDC or 24VAC.

5. The power/data back box shall allow entry of cables from the bottom of the dome that pass through watertight fittings.

6. Various types of mount shall also be available to accommodate various types of mounting surfaces (i.e. wall, ceiling, or parapet) and/or mounting installations.
7. The assembly shall provide both input and output alarm trigger connections.

8. The IP dome camera shall have a 3-axis gimbal providing 360° pan, 90° tilt and 350° azimuth for easy camera positioning.

9. The camera shall provide for audio input/output: Microphone/Line In and Line Out

10. The camera shall be vandal and tamper-resistant.

11. The product shall be available with any of the following lenses: An integrated 3-13mm megapixel IR corrected varifocal lens with F1.4, and 1 / 2.5” optical format.

12. To simplify lens setup during installation, an analog output for a display monitor shall be accessible when the lens housing is separated from the camera housing. TCP/IP protocol video output via a RJ-45 Ethernet connection and an NTSC (PAL) analog video output via a BNC connection outputs may be used simultaneously.

13. A mechanical reset button shall be available to return the camera to the factory default setup.

14. The IP dome camera shall conform to the ONVIF and to the PSIA standards.

C. Camera Specifications:

1. The Day/Night high-resolution color camera specified shall incorporate a progressive scan CMOS imager with a 1/2-inch optical format, not less than 5.0 million pixels and shall have a dichroic infrared mirror.

2. The image resolution shall be minimum 2560(H) x 1920(V) pixels. The camera’s aspect ratio (horizontal vs. vertical lines) shall be user configurable and not limited to only 4:3 or 9:6 aspect ratios. The camera shall produce 10 frames per second (fps) at full 2560(H) x 1920(V) resolution and at either 4:3 aspect or 16:9 aspect ratios.

3. The IP Dome camera shall have three video streams that can be independently configured for H.264 and MJPEG from the webpage and API interface. The IP dome camera shall have three video streams that can be independently configured for different resolutions. The IP dome camera shall have quality control over the MJPEG image stream with four selectable quality values from the webpage interface and with 86 selectable compression values from the API interface.

4. Minimum light requirement to produce a color image shall be approximately 0.30 lux (0.03 fc) with a f1.2 lens. When in the IR sensitive Night mode, less than 0.05 lux (.005 fc) will produce a black and white image. The IP dome camera shall provide an automated IR filter that will automatically switch from color to monochrome enhancing low lighting or in applications where IR illumination is utilized.
5. The camera shall provide automatic white balance, automatic exposure, gain control, electronic shutter, and backlight compensation. Dome camera dynamic range shall be 71dB. It shall use H.264 and MJPEG video-compression. The images can be viewed via a standard browser.

6. A night mode feature shall slow the shutter speed down to enhance the nighttime sensitivity of the camera.

7. The camera shall have on-camera storage using Micro SD Class 6+. The Contractor shall provide a minimum 32GB card for on-camera storage purposes.

8. Digital image authentication shall be optionally available and licensed to verify that images have not been altered, manipulated, or tampered with, in any way.

9. The camera shall provide on-screen time/date and text displays. The text display can be programmed to dynamically change when motion alarms are detected.

10. The camera shall provide built-in motion detection allowing up to eight separate, rectangular motion windows (zones) to be independently configured. Each window may have its interior pixels included or excluded from consideration by the motion detection algorithm. Windows configured to have pixels included in the motion calculations shall allow the threshold of both the sensitivity (pixel values) and size (quantity of pixels) to be set.

11. The camera shall provide on-screen, digital, pan/tilt/zoom on live or recorded video.

12. Provide User and Administrator password protection levels.

13. Up to eight (8) rectangular privacy windows may be configured to mask out specific video from view in the image. Dome camera shall provide image cropping.

14. The camera shall capture image sequences by time lapse intervals or trigger events and transfer the jpeg images via FTP and/or e-mail.

15. Specialized software that enables multiple users to receive alerts via a pop-up window when the camera receives an internal or external trigger shall be available via an optional license upgrade.

16. Dome camera will allow for an optional license upgrade that allows the creation of day and night configuration files for image optimization.

D. Camera Networking Requirements:

2. Camera functionality shall be available to users running versions of Java VM and web-browser applications released after January 1, 2004.

3. The camera shall provide integrated support for TCP/IP, HTTP, HTTPS, DHCP, UDP, RTP, RTSP, DNS, ARP, ICMP, NTP, UPnP, ZeroConf, APIPA, UDP multicast, SNMP, FTP, SMTP, Telnet, CIFS protocols.

4. The camera shall provide a multiview function where a single browser page shall be capable of displaying streaming images from up to nine cameras simultaneously.

5. No unique or proprietary client software shall be required for viewing or controlling the camera.

6. The camera shall be user configurable and the administrator may functionally or aesthetically modify the camera’s web pages.

7. The camera shall provide for up to 64 area-of-interest streams that can be independently created of any size and aspect ratio and with any desired display resolution. Substream frame rate can also be configured, up to the maximum frame rate delivered by the camera.

8. The camera shall offer a web interface for quick creation of up to eight substream windows with auto-port configuration of each stream.

E. Camera Recording/Playback Requirements:

1. The IP dome camera shall support on camera storage of time lapse and event recording using micro SD Class 6+ media.

2. Images may be stored at a fixed periodic record rate and/or when triggered by motion and/or external input. Playback shall allow all images recorded to be viewed forward or backward in time.

3. The camera shall record all images in a proprietary file format.

4. The camera shall include pre-event and post-event recording, time-date search, JPEG snapshot, and AVI export functionality.

5. The dome camera shall allow for an optional license upgrade that creates a unique encrypted digital signature that identifies the camera that produced the image and detects if the image has been altered.

F. Event (Alarm) Handling Capability:

1. The IP dome camera shall have an event handler allowing the camera to send an image or video clip to on-camera storage, FTP site, email address, and or network attached storage when receiving an internally or externally generated event.

2. When triggered from an external input or the camera’s motion detector, the camera shall be capable of sending JPEG images via e-mail and/or sequences of images to an FTP server.
3. A relay output shall be available upon the activation of the camera’s motion detector or external relay input. The relay output may also be manually activated from the live view screen.

G. Connections:
1. RJ-45 Ethernet connector (IEEE 802.3af PoE compliant)
2. Punch Down terminal for CAT5, CAT5e, or CAT6 cable
3. Screw terminal: Direct power for 12-24VDC or 24VAC, Trigger In and Trigger Out
4. Analog Service Port: for NTSC and PAL video outputs with 1Vp-p levels
5. Micro SD Card Media Slot
6. Alarm I/O terminals

H. Electrical Specifications:
1. Power Consumption: 5.3 watts maximum
2. Power requirement: 12-24VDC or 24VAC or via IEEE 802.3af Power-over-Ethernet on CAT5, CAT5e, or CAT6 cable

I. Mechanical Specifications:
1. Weight (without lens): 96oz (2839g)
2. Dimensions: 15.36 L x 5.18 W x 9.58 H inches
3. Lens: As required by the application
4. The camera shall feature solid-state components to resist shock and vibration and have no moving parts

J. Environmental Specifications:
1. Temperature range: -4 deg. F to +122 deg. F
2. Environmental Enclosure rating: IP66/NEMA 4

K. Certifications and Approvals:
1. Electromagnetic Compatibility:
   a. Emissions:
      i. FCC, class A part 15
2. Safety:
   a. EN 60950-1:2001 with A11:2004
   b. IEC 60950-1:2001

3. Restriction of Hazardous Substance (RoHS): All material and/or components used in the manufacture of the product shall be in compliance with the EU Directive 2002/95/EC RoHS.

L. IP camera assembly shall be IQinVision model IQeye Alliance Pro Series, IQA35NE-B6 or Caltrain approved equal.

2.04 INTEGRATED PTZ IP CAMERA ASSEMBLY

A. Product Description

1. The specified product shall be a high-resolution, PTZ HD Rapid Dome, 10X optical zoom, 360 degree pan rotation and a tilt range of 210 degrees, Day/Night network camera assembled into a rugged, sealed outdoor IP66 and/or NEMA 4X rated enclosure designed for both indoor and outdoor applications. The integrated camera is an industrial grade, color, and full-featured, day/night PTZ HD network camera.

   The assembled unit shall consists of 1) a camera and lens module; 2) enclosure; 3) a wall, ceiling, or pole mounting, 4) heater/blower; 5) 120VAC in and 12VDC and 24VDC out power supply; 6) fiber optic media converter; and 7) a power/data connector back box.

   The camera and heater/blower shall be powered by 12VDC output of the camera enclosure power supply. The fiber optic transceiver shall be powered by 24VDC from the camera enclosure power supply. The camera enclosure power supply shall be powered by 120VAC brought from the adjacent DC or CER. The 120 VAC power and communications single-mode fiber optic cables shall be run together within the same raceway.

   The product shall be designed to meet or exceed industrial and surveillance applications requiring a low power, rugged PTZ video camera with IP network capability. The camera shall have a built-in web server and FTP server.
B. General Product Requirements

1. The specified product shall be a high-resolution, PTZ, Day/Night 1/3-inch HD CMOS optical format, network camera integrated into an all-weather NEMA 4X / IP66 rated enclosure designed for both indoor and outdoor applications.

2. The operating temperature range shall be -20 deg F to +145 deg F.

3. The integrated camera shall be an industrial grade, color, and full-featured, Day/Night, PTZ HD network camera with 1/3-inch optical format.

4. The camera shall be powered directly via 12VDC from the enclosure power supply.

5. The enclosure shall house the camera/lens (while enabling its PTZ features), 120VAC power supply; heater/blower unit; fiber-optic transceiver; and shall allow entry of cables that pass through watertight fittings, which include harsh environment IP67 or better cable seal strain relief connector ports.

6. Various types of mount shall also be available to accommodate various types of mounting surfaces (i.e. wall, ceiling, pole or parapet) and/or mounting installations.

7. The assembly shall provide both input and output alarm trigger connections.

8. The camera PTZ features shall include a built-in 10X optical, auto-focus zoom lens, and 12X digital zoom capability; and capable of 360 degree pan rotation and a tilt range of 210 degrees. Zoom movement speed shall be of approx. 1.0 second (optical wide to optical tele). Maximum pan/tilt speeds of 400° per second and minimum pan/tilt speeds of 0.1° per second.

9. The camera shall provide for audio input/output: Microphone/Line In and Line Out.

10. The camera assembly shall be vandal and tamper-resistant, featuring camera tampering detection function that alerts the operator if the camera is tampered with. Tampering can include spraying the camera lens, covering it with a cloth, or changing the mounting direction.

11. The product shall be available with any of the Integral 10X (5.1 to 51 mm) F1.8 to F2.1, Auto-focus zoom and IR compensated type lens.

12. To simplify camera setup during installation, an analog output for a display monitor shall be accessible when the lens housing is separated from the camera housing. TCP/IP protocol video output via a RJ-45 Ethernet connection and an NTSC (PAL) analog video output via a BNC connection outputs may be used simultaneously.
13. The fiber optic transceiver/media converter shall convert incoming (over two fiber optic single-mode strands terminated with SC connectors) 100BASE-FX (1310 nm) signal into traditional copper 10/100BASE-TX (RJ-45) signal connecting to the camera network port. The media converter shall be powered by 24VDC output of the enclosure power supply.

C. Camera Specifications:

1. The Day/Night high-resolution color camera specified shall incorporate a progressive scan CMOS imager with a 1/2-inch optical format, with 720p HD resolution.

2. The image resolution shall be minimum 1280(H) x 720(V) pixels. The camera shall produce 30 frames per second (fps) at full 1280(H) x 720(V) resolution in 16:9 aspect ratio. It shall use JPEG, MPEG-4 and H.264 Triple Codec video-compression. The images can be viewed via a standard browser.

3. The camera shall incorporate a built-in 10X optical and 12X digital zoom capability with integrated 5.1 to 51 mm F1.8 to F2.1 auto-focus zoom lens.

4. Minimum light requirement to produce a color image shall be approximately 1.9 lux. When in the Night mode, less than 0.17 lux will produce a black and white image. The video signal-to-noise ratio shall be more than 50dB.

5. The camera shall provide automatic white balance, automatic exposure, gain control, electronic shutter, and backlight compensation.

6. The camera shall be capable of guard tour, which can be used to program up to sixteen (16) presets and moves to each preset sequentially when guard tour is activated. It shall be capable of shadow tour, which is used to learn an operator's PTZ control actions (including those made with a joystick) and then repeats the motions on command.

7. The camera shall be capable of recording image and sound files on the 8 MB of built-in memory or transferring the files to an FTP server. The camera shall have a built-in compact flash card slot to allow the use of additional compact flash memory, or allow the use of the manufacturer specified compact flash wireless LAN card (SNCA-CFW5). The Contractor shall provide for suitable 32GB card (minimum) for additional storage of the camera data.

8. The camera shall have RS-232C, RS-422, and RS-485 interfaces and support the Pelco D and VISCA Protocol. It shall also have a 14-pin I/O interface located on the rear of the base. There shall be four alarm input ports, and two Alarm/relay output ports. The Alarm input port shall be opto-isolated.

9. The camera shall be capable of 360 degree endless pan rotation and a tilt range of 210 degrees with maximum pan/tilt speeds of 400 degrees.
per second and minimum pan/tilt speeds of 0.1 degrees per second. It shall incorporate a built-in 10X optical and 12X digital zoom with zoom movement speed of approximately 1.0 second (optical wide to optical tele). The camera shall have ten (10) user defined presets, with a repeatable mechanical preset accuracy of ±0.045° (typical). It shall be capable of an e-flip function, a feature when the camera passes the down position, electronically flips the image 180 degrees.

10. The camera shall provide for built-in Intelligent Motion Detection (IMD) capability. To minimize false triggers, the IMD shall compare the current image with prior 15 frames within the camera. The IMD algorithm shall allow the camera to discriminate against some environmental noise such as shaking leaves or AGC noise. IMD function shall support at least five Video Motion Filters (VMF) to trigger alarms based on pre-defined rules. The camera shall have a “camera tampering” detection function that alerts the operator if the camera is tampered with. Tampering can include spraying the camera lens, covering it with a cloth, or changing the mounting direction.

11. The camera shall provide on-screen, digital, pan/tilt/zoom on live video.

12. Provide User and Administrator password protection levels.

13. The camera shall be capable of masking up to thirty two (32) privacy areas and provide for image cropping.

14. The camera shall capture image sequences by time lapse intervals or trigger events and transfer the jpeg images via FTP and/or e-mail.

15. The camera shall support IEEE-802.1X authentication.

16. Provide any specialized software required for setup and optimization of the camera.

D. Camera Networking Requirements

1. The camera shall support 10/100BASE-TX communications and incorporate a built-in web server, built-in FTP server, and a built-in FTP client.

2. Camera functionality shall be available to users running versions of Java VM and web-browser applications released after January 1, 2004.

3. The camera shall provide integrated support for TCP, IPv4, IPv6, DNS, RTP/RTCP, RTSP, UDP, ARP, HTTP, HTTPS, ICMP, SMTP, FTPs, FTPc, DHCP, NTP and SNMP (MIB2) protocols. Network security shall be via Password (basic authentication) and IP filtering.

4. The camera shall be capable of supporting up to ten (10) users simultaneously over the network. It shall be capable of dynamic IP address change notification. It shall accomplish this via an email to a specified address or by HTTP when its IP address changes.
5. The camera shall be compliant with the ONVIF (Open Network Video Interface Forum) specification.

6. The camera shall be user configurable and the administrator may functionally or aesthetically modify the camera’s web pages.

7. The camera shall have up to six user-specific level settings. The camera shall have an Adaptive Rate Control (ARC) function when using MPEG-4 and H.264 compression. This function when enabled, shall allow the camera to maintain the frame rate at a reduced image quality when network congestion occurs. Should network bandwidth become further restricted, the frame rate shall then drop automatically to a suitable speed to maintain image integrity.

8. The camera shall offer a web interface, 802.1X authentication; support QoS technology and user configurable port settings.

E. Camera Recording/Playback Requirements:

1. The manufacturer shall offer optional, licensable embedded recording/playback software that allows images to be recorded to an external FTP server or locally to on-camera an asbuilt memory or media card.

2. Images may be stored at a fixed periodic record rate and/or when triggered by motion and/or external input. Playback shall allow all images recorded to be viewed forward or backward in time.

3. Recorded images and data storage shall be no less than 14 days.

F. Camera Event (Alarm) Handling Capability:

1. The camera shall be capable of recording an event as pre and post event images to an asbuilt memory or an on-board Media Card. The camera shall also be able to transfer the event’s JPEG images to an FTP server via File Transfer Protocol (FTP). Events may be triggered using camera motion detection or from an external device input such as a relay.

2. When triggered from an external input or the camera’s motion detector, the camera shall be capable of sending JPEG images via e-mail and/or sequences of images to an FTP server.

3. A relay output shall be available upon the activation of the camera’s motion detector or external relay input. The relay output may also be manually activated from the live view screen.

4. The camera shall support Voice alert function, which can automatically play an audio file stored on the camera by an alarm trigger using motion detection, DEPA Advanced VMFs, camera tampering detection or via a sensor input.
G. Camera Connections:
1. RJ-45 Ethernet connector
2. Punch Down terminal for CAT5, CAT5e, or CAT6 cable
3. Screw terminal: Direct power for 12VDC or 24VAC
4. Analog video: 75 Ohm BNC connector
5. Analog installation setup port: RCA Female
6. Card Media Slot
7. Alarm I/O terminals
8. Audio: mini-jack connectors to support external microphone and active speakers

H. Camera Electrical Specifications:
1. Power Consumption: 30 watts maximum
2. Power requirement: either AC 24V or DC 12V

I. Camera Mechanical Specifications
1. Dimensions: approximately 6 1/8 inches (Dia.) x 9 inches (H) (not including the projecting parts)
2. Lens: As required by the application

J. Camera Environmental Specifications
1. Temperature range: +32 deg. F to +122 deg. F
2. Operating humidity: 20% to 80% (non-condensing)

K. Camera Enclosure Requirements
1. Camera Enclosure shall be designed to provide for a fully functional housing for the CCTV Ethernet network camera specified herein.
2. It shall be designed for CCTV cameras for commercial, industrial, or government applications requiring a rugged, sealed outdoor rated camera enclosure with compatibility to house a broad range of Pan Tilt Zoom (PTZ) or fixed Mini-dome cameras that are commercially available for IP, and High Definition, and CCTV capability. The Camera Enclosure shall be minimal outdoor protection rating of IP66 and/or NEMA4X. The Camera Enclosure shall include harsh environment IP67 or better Cable Seal strain relief connector Ports.
3. The housing will provide power to compatible cameras @ 12 VDC & 24 VDC, and environmental control board for providing power to protective elements which could include two high output 10 CFM Fans, and integrated internal dual ply foil & foam insulation for optimal thermal protection.

4. It shall provide integrated capacity for bolt on wall and/or compatible with optional brackets with capacity for strap mounting pole mounting of enclosure. Provide for provision of any necessary mounting and cable management equipment to provide for a fully functional PTZ Camera assembly.

5. The Camera Enclosure shall be compatible with a media connection cable of Category 5 and/or Category 5 Enhanced and/or Category 6 twisted pair (UTP) cable, using RJ45 compliant connectors, & CCTV coaxial cabling.

6. Housing Power:
   a. Source Supply Voltage @ enclosure: 95-264VAC & 20-30VAC/VDC
   b. Voltage available to power Camera and accessories; 12VDC @ 25 watts max, and 24VDC @ 25 watts maximum. Total sum power to camera or accessories is 50 watts maximum.

7. Housing Mechanical Specifications:
   a. Exterior 14.9” (L) x 13.4” (H) x 11.7” (W)
   b. Interior: 8.6 (dia @ mount base) x 9.3 tall (6.8 dia. max @ lens) (maximum camera size)
   c. Hinged Lower with Captive Stainless Steel Fasteners
   d. Rugged Polycarbonate Housing (0.160” wall)
   e. Clear Acrylic Viewing Lens bubble 6.8” dia. x 3.7” deep
   f. White Semi-gloss finish to PC housing
   g. Protective Urethane foam Gasket Seals
   h. Integrated wall mounting tabs
   i. Integrated Omni Antennae mounting tab on side
   j. Certifications NEMA 4x / IP66

8. Housing Environmental Specifications:
   a. Operating Temperature Range: -20 deg F to +145 deg F
b. Housing shall meet or exceed a rating of NEMA4X and/or IP66

c. Housing shall have two cable entry ports rated to IP67 for power & data cables

d. Housing shall be suitable for deployment into wide range of moderate environments of Residential, Commercial, Industrial, Marine, Desert, and other indoor & outdoor installations.

L. Industrial Mini Media Converter Requirements:

1. Industrial Mini Media Converter shall be designed to provide for a fully functional fiber-to-copper Ethernet communications conversion for the CCTV Ethernet network camera specified herein.

2. Industrial Mini Media Converter shall provide for integration of fiber optic cabling into industrial or outdoor 10/100 UTP Ethernet networks. It shall feature wide operating temperature range, low-voltage DC power, multiple mounting methods and lifetime warranty, and shall be designed for harsh outdoor or industrial applications.

3. General Features:

a. Unit and Port LEDs to provide quick status

b. Auto-Negotiation

c. Fixed Full-Duplex on fiber

d. AutoCross™ on copper port

e. Link Pass Through

f. Automatic Link Restoration

g. Far-End-Fault

h. DC Powered

4. Specifications:

a. Fiber Ethernet Signal: 100BASE-FX, 1310 nm with link budget: 16.0 dB and max distances: 12.4 mi

b. Fiber Connector type: SC

c. Fiber type: Single Mode

d. UTP Ethernet Signal: 10/100BASE-TX

e. UTP Ethernet Connector type: RJ-45
f. Status LEDs: PWR (Power); FX-Link/Act (Fiber Link/Activity); TX-Link/Act (Copper Link/Activity)

g. Dimensions: Width: 1.8" x Depth: 3.3" x Height: 0.85"

h. Power Consumption: 2.5 watts

i. Power Sources: 12-48VDC

j. Operating Temperature: -40°C to 75°C

k. Humidity 5% – 95% humidity non-condensing

l. Regulatory Compliance FCC Class A, CISPR22/EN55022

m. Class A, EN55024, CE Mark

n. Warranty: lifetime

M. The following equipment shall be used:

1. IP camera shall be Sony model SNC-RH124 or Caltrain approved equal

2. IP camera outdoor housing shall be Dotworkz model D2 Tornado with MVP Multi-Volt Platform or Caltrain approved equal

3. The Industrial Mini Media Converter shall be Transition Networks model M/E-ISW-FX-01(SM) or Caltrain approved equal

2.05 CABLING

A. Furnish and install a UTP Category 6, 4-pair cable with RJ45 connectors between the assigned Distribution Cabinet or CER and the camera location.

B. Furnish UTP cables that are terminated at the CCTV camera end and at the surge suppressor at the cabinet’s or CER’s point of entry. Install the cable from the CCTV camera end to the cabinet termination point leaving sufficient slack in the cable for normal camera operation and maintenance. Provide slack cable in the CCTV cabinet in accordance with the design.

C. Provide cables to connect from the UTP or composite cable termination points (i.e., termination point with surge suppressors) to the redundant Ethernet switch located in the assigned Distribution Cabinet or CER.

D. Where design prohibits use of UTP cabling (due to cabling distances exceeding 300 ft or high EMI levels) furnish, install and terminate a 4-strand single-mode fiber cable. Such installation shall be accompanied by the corresponding installation and termination of the CCTV 120VAC UPS-backed power wiring and shall be routed in separate raceways from the power wiring for the station’s remaining subsystems. The corresponding standard Media Converter or Media Converter with IEEE802.3af PoE/PSE supply (i.e. Etherwan model EL1032 or Caltrain approved equal) shall be implemented on the receiving end as per the project design.
E. As a part of the Design Submittals, prior to installation and termination of the CCTV System conduits and cabling, submit to Caltrain for approval the conduit and cabling labeling scheme. See Caltrain Standard Specifications Section 17050, Basic Communications Equipment, Material and Methods.

2.06 CCTV MOUNT

A. Furnish and install the CCTV camera assembly-mounting arm at locations as shown on the Contract Drawings and all necessary attachment hardware, grounding and miscellaneous hardware. The mounting arm shall mate with the CCTV assembly support pole.

B. A conduit passageway through the pole at the camera-mounting arm shall be used to pass the UTP and/or, where applicable, other cables through the pole to the CCTV mounting arm and then into the CCTV camera assembly.

C. The cabling may be a combination CCTV communication and power cables. The arm shall completely conceal all cables so there is no exposed wiring outside the pole, cabinet and camera.

D. The attachment of the CCTV camera assembly to the mounting arm and the electrical connections and the attachment of the arm to the camera support structure shall be in accordance with the camera manufacturer’s installation recommendations. The arm mounting to the support pole shall not use “U” bolts or banding as the attachment hardware.

E. The design of the attachment hardware shall provide a secure connection between the pole and the camera-mounting arm. The design and fabrication of the CCTV mounting arm to support pole hardware shall be submitted for review and approval to the Engineer. Provide a Caltrain approved CCTV assembly-mounting arm that meets the structural, functional and aesthetic needs of the project. The required mounting arm may or may not be an off the shelf product provided by the CCTV camera assembly manufacturer or vendor. It shall be acceptable to design and have fabricated a specialty arm that shall meet the specific needs of the project subject to Caltrain’s approval.

2.07 NETWORK DIGITAL VIDEO RECORDER (DVR)

A. General Product Description:

1. This description lists the technical specifications for the station video Nextiva Recorder Server.

2. All software components shall be part of the manufacturer’s standard software product offering. All software components shall be thoroughly tested and proven in reference installations. The Network Video Recorder solution shall be DHS certified as an anti-terrorism technology.

3. The station DVR solution shall have flexible, open architecture built on accepted industry standards that support a Workgroup Windows Environment; Active Directory Domain Environment and unified workstation logon based on Windows authentication. The station DVR shall have flexible configuration architecture that facilitates video
resolution transcoding in order to stream video in a low bandwidth connection to the Review and Client SDK applications.

4. The specified product is an all-in-one multichannel (a channel per a camera) Network Video Recorder, providing for recording, local and remote surveillance; intelligent video analytics and enhanced file security by digital watermark required by the station CCTV System.

5. For recording functions, the device supports continuous/ manual/ schedule recording; alarm recording (by motion detection or sensor triggered); multiple alarm recording schedules; megapixel recording; Motion-JPEG, MPEG-4, MxPEG and H.264 recording; audio recording (vary by camera models).

6. For surveillance functions, the device supports diversified modes for live monitoring; smart control of PTZ cameras and auto cruising; event notification on monitoring; real-time SMS and email alert; multi-channel playback at different speed; easy data search by date & time, timeline, event, and intelligent video analytics (motion detection, foreign object, missing object, out of focus, and camera occlusion).

7. The station DVR shall provide support for IP (network) cameras from multiple third party manufacturers and various encodings including MJPEG, MPEG-4 and H.264.

8. The station DVR shall support video motion detection natively. This operation can be executed by the edge device or the IP Camera. Enabling motion detection shall be performed either: on a continuous basis; scheduled for particular times, dates, days, months, etc.; defined areas of interest through an easy-to-use user interface using simple editing tools; and/or at a defined level of sensitivity.

9. The Recorder shall use standard COTS (Commercial Off-The-Shelf) server technology and storage attachments including certified for EMC storage solutions. Video storage implementations for the station DVR shall be either be internal, external SCSI-attached, external Fibre Channel-attached, or external iSCSI SAN (depending on the application’s functions, storage and performance requirements).

7. The station DVR solution shall be capable of supporting multiple site locations linked via LAN / WAN connections.

B. Station DVR Interfaces:

1. The station DVR shall support the ability to support third-party IP cameras via the Service SDK which can be used to develop adaptors for any IP camera.

2. The station DVR shall support H.264, MJPEG and MPEG-4 compression from edge devices and IP cameras.

3. The station DVR shall support H264 de-compression on the Workstations.
4. The station DVR shall support an unlimited number of dry-contact inputs.

5. The station DVR platform shall support an unlimited number of dry-contact outputs.

6. The station DVR shall operate over a Local Area Network (LAN)/Wide Area Network (WAN), using a standard Ethernet 100/1000 Base-T connection.

7. The station DVR shall support either or both Unicast or multicast over the enabled network.

8. The station DVR shall transmit video using the UDP/IP or TCP/IP communication protocol.

9. The station DVR shall transmit all command and control messages using the TCP/IP protocol.

10. The station DVR shall generate alerts on disabled camera inputs.

11. The station DVR shall support the ability to support third-party keyboards via the Service SDK which can be used to develop adaptors for any third party Keyboard.

12. The station DVR shall support additional PTZ Keyboard Camera Commands such as:
   a. Call up Patterns
   b. Camera Menu Commands
   c. Auxiliaries
   d. Home Position
   e. Flip Camera 180 degrees

13. The station DVR shall support all station CCTV equipment installed under the current project.

14. The station DVR equipment shall be fully compatible with the existing Caltrain Nextiva CCTV Hardware and Software Head End located at Caltrain Headquarters in San Carlos.

C. Station DVR Requirements:

1. The station Recorders shall store video on COTS equipment using hard drives as storage medium. The recorders also have the capability to support the attachment of external storage devices.

2. The station Recorders shall be certified with optional EMC storage solutions.
3. The station Recorders shall be certified to Record in VMware environment.

4. The station Recorder Server shall be configured to run Master Server functions, Recording, Storing, Media Gateway Server, Live View and the Review applications simultaneously (including simultaneous support of multiple users/streams/views) for cost-effective deployments. The Contractor shall select vendor-recommended hardware and software for the station DVR to be able to support such performance requirements for multiple simultaneous tasks operations (with no task interfering with any other task).

5. The Recorder shall run autonomously and continue to Recorder once configuration is received.

6. The Recorder shall support the ability to fail-over to another recorder or group of Recorders dynamically without user intervention.

7. The station Recorder Server shall have the ability to record simultaneously all station cameras at their maximum resolution and the lowest level of compression (maximum quality); and store the recorded CCTV video at the local station storage for at least 14 days. Also, to support future growth, the performance and storage of the station DVR equipment shall be rated to handle additional 50% of similar station CCTV equipment. As a part of the design submittals, submit all necessary calculations for performance and storage requirements of the CCTV system and identify adequate and up-to-date equipment/software similar to the lists below.

8. The station DVR and, if applicable, external storage shall utilize High Reliability and Smart Features, such as:
   a. Advanced RAID (RAID 5/ 5 + hot spare/ 6/ 6 + hot spare/ JBOD) with hot-swap design
   b. Large storage capacity for long-term recording
   c. Intelligent auto power on when power resumes after power outage
   d. Supports UPS for 24x7 service
   e. Two Gigabit LAN ports for failover, load-balancing, or multi-IP setting

9. The minimum requirements for a server hosting Master Server and Recorder services with internal storage are listed below.
   a. Processor and Speed: Vendor recommended microprocessors based on up-to-date available hardware and to meet functional requirements above
b. Memory: Vendor recommended memory type and size based on the up-to-date available hardware and to meet the functional requirements above

c. Boot Drive: 2 X 80 GB SATA in RAID 1 configuration

d. Video Storage Drives: SATA with capacity and redundancy as specified

e. Operating System:
   i. Win2003 SE Server R2, SP1 or SP2
   ii. Windows 2008 SP2

f. Video Card: 128 MB RAM, 1024x768

g. NIC: 100/1000 BASE

h. 8X DVD Writer

10. The minimum requirements for a server hosting a Master Server and Recorder with external storage for video are listed below:

   a. Processor Speed: Vendor recommended microprocessors based on up-to-date available hardware and to meet functional requirements above

   b. Memory: Vendor recommended memory type and size based on the up-to-date available hardware and to meet the functional requirements above

   c. Boot Drive: 2 X 80 GB SATA in RAID 1 configuration

   d. Operating System:
      i. WIN XP + SP2
      ii. Win2003 SE Server R2, SP1 or SP2
      iii. or Windows 2008 SP2

   e. Video Card: 128 MB RAM, 1024x768

   f. NIC: 100/1000

   g. 8X DVD Writer

11. Media Gateway Server requirements:

   a. In order to enable live views at the Caltrain Headquarters headend of the station’s high resolution cameras over the existing Caltrain low-bandwidth WAN links (partial T1 lines
between stations and the Caltrain Head End CCTV equipment), the station DVR shall provide for the Media Gateway functionality.

b. The Media Gateway Server shall be capable of running all video transcoding and WAN transport services. The Media Gateway Server shall transcode received video from IP cameras or edge devices at a certain resolution and then convert and send the low resolution video through a bandwidth limited WAN link.

c. The Media Gateway shall properly packetize video to transverse NAT’s and Firewalls using IP with a maximum of 2 ports.

d. The Media Gateway shall support Review User Priorities when multiple remote Review user requests for video exceed the bandwidth of the WAN/LAN link.

D. Station DVR General Software Requirements

1. The station DVR shall have a graphical user interface (GUI) that allows the user to quickly configure and apply the following parameters:

a. All cameras configurations

b. All recorder configurations and resolutions

c. All work schedules

d. User and access rights and privileges

e. Create schedules and apply them to specific camera groups

f. Configure cameras and recorders individually and as a group in system components

g. Support event management and recording; establishment of rules and follow up actions

h. Video storage locations, settings and schedules; and management of long-term storage and archiving

i. Add and edit interactive site plans and Maps

j. View live video, retrieve recorded video, and export video into desirable media (authenticate video to enable users to verify that the video has not been modified since it was recorded). This includes viewing of live or historical alarm events and the associated video by scanning of recorded video for activity thru an energy graph that indicates levels of activity.

k. Manage multiple windows (up to 16) and the associated rules and priorities
l. Control PTZ cameras and configure PTZ presets/patterns/tours

m. Group cameras and maps at and define multiple levels of groups and maps

n. Support digital zoom on live or recorded video, without requiring a video pause

o. Manage images’ date and time, text annotation, adjust the brightness and/or contrast; smooth, sharpen, grayscale and other filtering

p. Select video to be exported and from a precise start time and end time

q. Save the image to disk in various standard file formats

r. Be video analytics ready

s. Support failover/redundancy (where required)

t. Configuration of the Media Gateway functionality for downscaling high resolution video-streams into resolutions of lower quality and lower bandwidth requirements for live view of such images at the Caltrain CTV Head End via the low bandwidth (partial T1) WAN links to the stations

u. Support setup of health check settings for live monitoring and detailed system performance metrics on system components, including all server-side software applications, edge devices, and cameras (including cameras’ out-of-focus, tampering detection and full/partial blockage of the view)

2. Prior to implementation and configuration of the station DVR, for each Design Review Level, submit for Caltrain’s approval the proposed settings for all software functions described above.

E. Product, Server and Storage requirements:

1. The station DVR shall be Verint Nextiva Recorder Server with internal storage on the Dell PowerEdge R710 platform (or the most current approved substitute), and the Nextiva Recorder Server with external SCSI or Fibre Channel storage on the Dell PowerEdge R410 platform (or approved up-to-date hardware platforms recommended by the vendor). The chosen platforms shall meet the storage and performance requirements listed within these specifications (based on the Contractor calculations and approved by the Caltrain).

2.08 UPDATES TO THE CALTRAIN EXISTING CCTV HEADEND SOFTWARE

A. As a part of the Design Submittals, submit to Caltrain for approval the IP addressing scheme and security scheme for all station CCTV System elements.
B. Caltrain will program into the existing Caltrain CCTV Head End Verint software the new station CCTV cameras, DVRs and other CCTV network elements. The Contractor shall assist the Caltrain personnel with the integration (and the associated configuration/testing) of the station CCTV equipment into the existing Caltrain CCTV Head End.

PART 3 - EXECUTION

3.01 INSTALLATION

A. At locations where new cabinets are installed, new UPS electrical services shall be installed as shown on the plans. The new electrical services shall be sized to accommodate the equipment to be installed in the cabinets.

B. Where multiple subsystems devices share the same pole or location, provide separate Category 6 or fiber optic cabling and conduit per device. Subsystem devices shall not share cables conduits, or other pathway.

C. Integrated Camera Assembly: Install an integrated camera assembly, UTP or composite cable, camera interface panel, and camera-mounting arm at locations as show in the Contract Drawings.

D. Where cameras are located less than 9 feet above the surrounding ground surface physical protection shall be utilized to protect them from vandalism.

E. No field cabinets shall be used for the CCTV at camera positions. The CCTV camera shall stand alone with Category 6 or fiber optic cable connectivity to its assigned Distribution Cabinet or CER (whichever is closer or practical).

F. CCTV Assembly Installation:

1. Mount the CCTV assembly on the mounting arm in accordance with the manufacturer's recommendation and at locations as shown in the site specific drawings. Install the camera assembly UTP or composite cable in accordance with the routing as shown in the Contract Drawings. Make all necessary cable connections.

2. Feed all cable connections from the CCTV Camera assembly leaving sufficient slack in the cable for normal movement and maintenance of the CCTV camera assembly. After installation and cable termination an initial test shall be performed to confirm that the camera has been installed properly and functions correctly from the CCTV cabinet location. This initial test is not a replacement or substitute for any acceptance test.

3. Perform the CCTV assembly manufacturer's initial power-on test in accordance with the manufacturer's recommendation. Ensure that the camera assembly receives all pan/tilt/focus/zoom telemetry settings by exercising the camera assembly to verify each telemetry function.

4. Perform additional testing conforming to any other CCTV camera manufacturers recommended procedure to confirm that the initial functionality is operational. With either a test monitor or other device as
recommended by the CCTV Camera assembly manufacturer confirm that a video image is present from the installed camera assembly.

G. CCTV Mount:

1. Furnish and install a mounting bracket for a pole mount, which includes the pole attachment hardware, clamps, bolts and bracket arm. “U” bolts and strap supports will not be allowed.

2. Mount the CCTV mounting bracket at the cardinal direction as shown in the Contract Drawings. Ground the mounting arm as shown in the Contract Drawings.

H. CCTV Connectivity:

1. Install CCTV camera to include UPS power receptacles, dc power supply, terminal strips, lightning and voltage suppressors, grounding strips, and internal wiring.

2. Connect camera UTP or fiber-optic cable connector(s) to integrated camera assembly per manufacturer installation manual. Terminate camera cables in cabinet as follows:

   a. Power: Terminate ac/dc+, ac/dc-, and ground wires and connect to camera power supply surge suppressor provided in cabinet. All CCTV equipment shall utilize UPS backed power.

   b. Fiber Optic Communications: Fiber Optic cabling shall be 4 strand single-mode cable suitable for outdoor installations and made of non-metallic elements. Terminate all 4 strands of the single mode fiber optic cable with SC connectors at each end of the cable. Connect two of these strands to the fiber optic transceiver / media converter inside the camera enclosure and at the corresponding media converter at the Station LAN redundant Ethernet switch within DC or CER (whichever is closer). These two strands will be used for the video communications and the remaining two strands will serve as “ready to use” spare.

   c. Video: During the initial field setup, if available, terminate coax cable with BNC connector as per manufacturer recommendations. For UTP cable, use RJ45 connectors.

   d. Wiring, Conductors and Terminal Blocks: Use stranded copper for all conductors, including those in jacketed cables, except for earth ground conductors, which shall be solid copper. Neatly arrange all wiring, firmly lace or bundle it, and mechanically secure the wiring without the use of adhesive fasteners. Route and secure all wiring and cabling to avoid sharp edges, and conflicts with other equipment or cabling. Route camera copper communications wiring separately from 120Vac wiring. Terminate all wiring on a terminal block, strip, buss bar or device clamp or lug; do not splice any wiring. Use a minimum #12 AWG for all conductors for 120 Vac circuits except for the 120
VAC supply circuit for the camera and pan/tilt unit. The gauge of the power wiring for the PTZ camera assemblies shall be determined by the voltage drop and conduit fill ratio calculations. The minimum gauge for the PTZ camera assemblies’ power wiring shall be #16AWG. Install all wiring as shown in the Contract Drawings.

e. Neatly dress the cables in the cabinet, and reach the connectorized end to the mating connectors on the camera assembly with 3 foot slack. Cut unused conductors in the cables to the same length as the assigned conductors. Bend back the unused conductors over the outer jacket and individually tape them in a manner to prevent pinching by the CPC strain relief clamp.

f. All cables used in the cabinet are UL-listed tray cable with PVC/nylon insulation and UV-resistant PVC outer jacket rated for 600 V, 194 degrees F dry; 167 degrees F wet and wet/dry direct burial use. All furnished wiring used to complete the installation are to be rated at or above these minimum values. Video signal cable, when used, shall be high-flexibility double-shielded with tinned copper braid, #22 AWG stranded copper center conductor, and PVC outer jacket. Use BNC connectors on the video signal cable only as recommended by the cable manufacturer. Confirm during testing that this two-way data path is present and active. For IP fixed cameras, UTP cable shall be TIA/EIA Category 6, 4-pair solid conductor, rated CMR and placed in metallic conduit between the network distribution cabinet and camera assembly.

g. Dress and route grounding wires separately from all other cabinet wiring. Install grounding wires with the absolute minimum length possible between the suppressor and the ground buss bar. Label all surge suppressors with silk-screened lettering on the mounting panel.

h. The cabinet shall be furnished with three-stage transient surge suppressors for protecting the camera control/feedback, video output, and power supply lines. These suppressors shall be in addition to the suppression provided by the CCTV camera equipment. For IP fixed cameras, UTP shall be protected at the network distribution cabinet with 4-pair solid-state protection rated for Category 6.

i. Install electrical cables used for video, control, communications signaling and power supply as shown in the Contract Drawings. Do not splice any cable, shield or conductor used for video, control, communications signaling, or power supply. Identify all conductors of all cables by color and number. Identify the conductor function in as-built documentation included in the cabinet documentation. Terminate cable used for analog video signaling in BNC connectors. After termination and dressing the cables in the cabinet, neatly coil and store a minimum of 3 foot
(.61m) of cable slack in the bottom of the cabinet. Cut unused conductors to a length that can reach any appropriate terminal. Bend back the unused conductors over their outer jackets and individually tape them.

j. Where used, provide a single UPS 120 / 24 Vac (60 Hz) power source to the camera assembly from the equipment cabinet to supply both the camera and the heater in the camera housing.

k. Install cabling between the CCTV camera assembly and the network distribution cabinet inside support poles, conduit, or structures as shown in the Plans. Use weather heads on all nipple and conduit openings. Neatly install and route cabling to minimize movement in the wind and chafing against the pole, device or bracket. Form a drip loop at the weather head and route cabling to minimize water entry into the cable connector. Lash cabling mounting arm and route into camera and pan-tilt unit.

I. Connect data cables from the CCTV equipment to the station LAN and configure the station DVR with approved settings for cameras, storage and other CCTV system related settings to make complete and fully functional station CCTV system.

J. Assist Caltrain personnel with incorporation of the new station CCTV equipment into the existing Caltrain CCTV system to ensure full integration of the new CCTV equipment.

3.02 TESTING AND INSPECTION

A. Acceptance testing consists of three phases: Field Installation Testing, CCTV System Site Testing, and Burn-in Period.

B. Field Installation Test:

1. Perform the Field Installation Test as an onsite test of the complete field installation assembly less the communications components. No acceptance testing at a given site can begin until all work associated with that site is complete, not including the communications components. For the field equipment installation test, a PC laptop system, camera control receiver-vendor control software (Caltrain provided) and a 13-inch or larger color video monitor shall be used to demonstrate full operation of the CCTV site. Proper operation is to include pan, tilt, focus, zoom, iris, and position feedback and communications address configuration.

2. Perform local field operational tests at the device field site and end-to-end video streaming tests in accordance with the test procedures below:

   a. Verify that physical construction has been completed as detailed in the plans

   b. Inspect the quality and tightness of ground and surge protector connections
c. Check power supply voltages and outputs

d. Connect devices to the power sources

e. Verify video image presence and quality with a vector scope and a portable NTSC approved monitor and DVD

f. Exercise the pan, tilt, zoom, focus, iris opening, manual iris control selection and operation, low-pressure alarm (if present), preset positioning, and power on/off functions

g. Demonstrate the pan/tilt speed and extent of movement to meet all applicable standards, specifications, and requirements

h. Demonstrate the ability to support IP unicast and multicast SAP and QoS

i. Configure the DVR IP addresses for video and data input

j. Verify proper voltages for all power supplies

k. Interconnect the communication interface device into the communication network's assigned fiber optic cable and verify network transmission activity.

C. Test the installed CCTV assembly at the bottom of the pole from the camera cabinet using test procedures specified herein and recommended by the CCTV camera assembly manufacturer.

D. CCTV System Site Test:

1. After the completion of the associated copper or fiber optic communication connection between the CCTV camera assembly and the associated DC cabinet to the station equipment room (CER), perform the CCTV System Site Test to demonstrate proper CCTV system performance at the CER. The CCTV System Site Test shall be performed only after successful completion of the field installation test. Proper operation is to include a satisfactory video image, areas of coverage, pixel per foot level of detail, camera/lens control, if applicable, PTZ controls, and communications operation from each CCTV site to the CER and Caltrain San Carlos CCTV Head End.

2. Test of all software functions of the station DVR for compliance with the Caltrain Engineering approved requirements and settings for the Station DVR hardware and software.

3. The demonstration shall use the central CCTV software and control center and communications system to demonstrate the compatibility of the CCTV equipment installation in its permanent configuration. Proper operation is to include a demonstration of proper data communications integrity with a communication protocol analyzer.
4. Caltrain shall witness and record the test data, date and time of successful completion of the test.

E. Burn-in Period:

1. The Burn-in Period starts after the Caltrain Engineering accepting the completion of the Field Installation Test and completion of the CCTV System Acceptance.

2. Any failure determined to be the result of faulty installation materials or workmanship shall be cause to restart the burn-in period. Correct any faulty material or workmanship that results found during the burn-in period. At the successful conclusion of the burn-in period Caltrain will accept the installation as complete.

3. The burn-in period shall determine if the system is capable of recording and storing the station camera images at the highest resolution and at the highest frame rates required by the Station Design.

4. The burn-in period shall be for a continuous 30 days and shall be performed for the station CCTV equipment as a whole.

F. Test the new station CCTV equipment is fully compatible with the existing Caltrain CCTV Head End as per Caltrain approved requirements and settings.

END OF SECTION