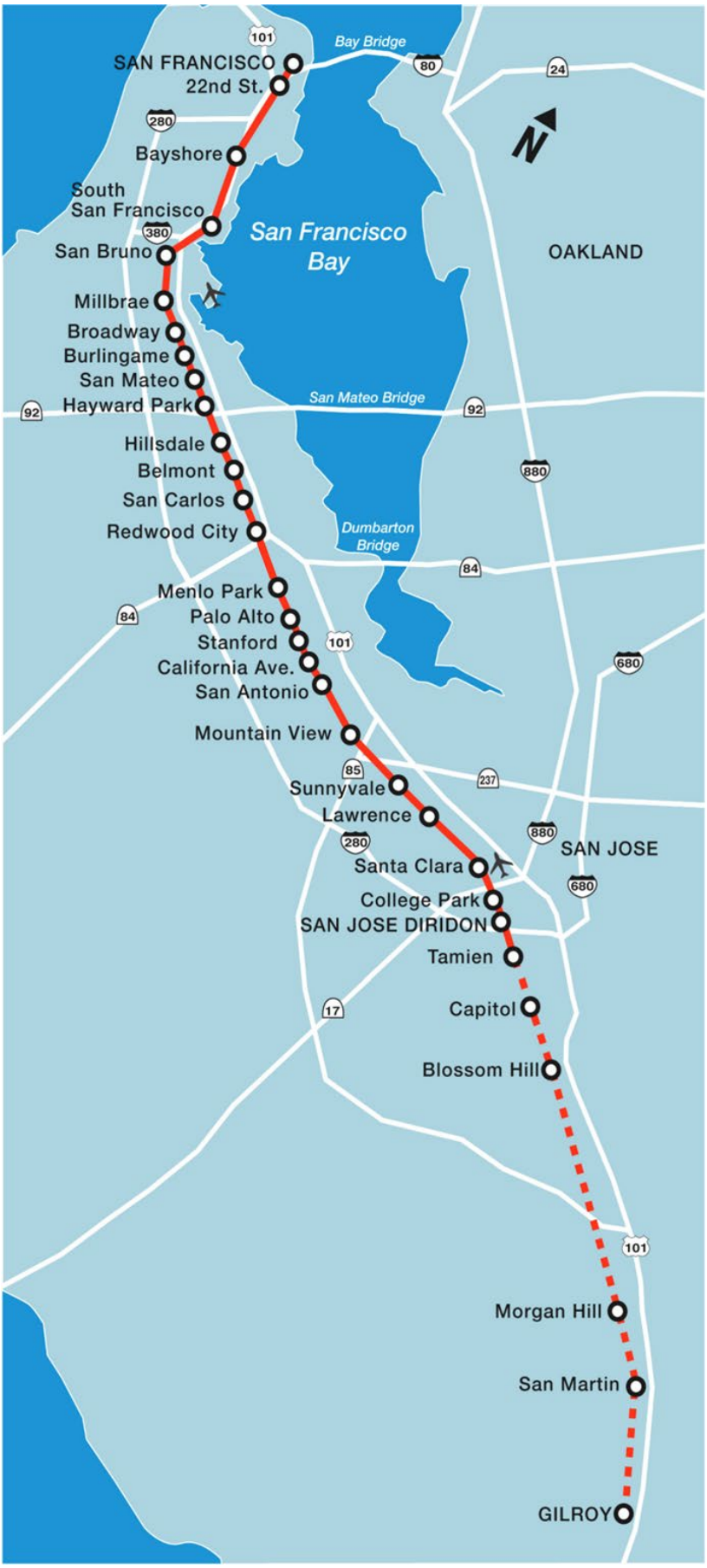
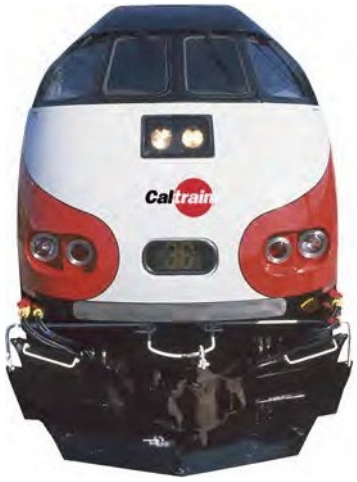
Peninsula Corridor Joint Powers Board
1250 San Carlos Avenue
San Carlos, California 94070-1306



STANDARD SPECIFICATIONS



FOURTH EDITION

JANUARY 1, 2024

CALTRAIN STANDARD SPECIFICATIONS
DIVISIONS 2 THROUGH 20

FOURTH EDITION
JANUARY 1, 2024

These Caltrain Standard Specifications supersede Standard Specifications dated August 31, 2020.

Check for any updates online as well as send any suggestions or changes through www.Caltrain.com.

Document Revision History

Date	Revision Description
April 15, 2007	First Edition
September 30, 2011	Second Edition
August 31, 2020	Third Edition
January 1, 2024	Fourth Edition

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DIVISIONS 2 THROUGH 20

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SECTION 02100
DEMOLITION

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes regulatory and general requirements for demolition.

1.02 REFERENCE STANDARDS

A. State of California, Department of Transportation Standard Specifications (Caltrans):

1. Section 14-11.12 Removal of Yellow Traffic Stripe and Pavement Marking with Hazardous Waste Residue

2. Section 15 Existing Facilities

1.03 RESTRICTIONS

A. Do not sell or burn removed materials on-site.

B. Do not use explosives.

1.04 SUBMITTALS

A. Demolition Plan: Submit demolition work plan for approval. Indicate methods to be employed, sequence, equipment, procedures, disposal sites, and proposed haul routes. Include safety measures in accordance with applicable regulations and codes, including signs, barriers, and temporary walkways.

1.05 DELIVERABLES

A. Submit permits and notices authorizing demolition, as required.

B. Submit copies of manifests showing delivery of disposed materials in accordance with permit conditions within 24 hours from time of delivery.

1.06 REGULATORY REQUIREMENTS

A. Perform work of this Section in accordance with applicable laws, ordinances, and requirements of the agencies having jurisdiction.

B. Unless otherwise specified, perform work in accordance with the following:

1. California Code of Regulations, Title 24: Part 2, California Building Code, Chapter 33, Safeguards During Construction.

2. American National Standards Institute (ANSI): ANSI A 10.6 – Safety and Health Program Requirements for Demolition Operations.

3. State of California Code of Regulations, Title 8: Cal/OSHA Construction Safety Orders

1.07 PROJECT CONDITIONS

A. Provide and maintain all required temporary construction and facilities for the support and protection of the existing structures to remain.

B. Protection and Interruption of Utilities: Refer to Specification Section 01047, Utilities and Systems Coordination, for location, notification, and protection requirements in regard to existing utilities and systems facilities.

C. Refer to Specification Section 01560, Temporary Controls, for requirements for dust control. Provide continuous dust abatement as required.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Provide temporary or permanent materials as required for the proper execution of the Work of this Section.

2.02 DUNNAGE

A. Provide pallets, sills and other materials for packaging and stacking salvaged items which are clean, free of decay or other defects, and sufficiently sturdy for the service intended.

2.03 MARKING PAINT

A. Marking Paint: Spray marking paint or paint marker, suitable for duration of service required.

PART 3 – EXECUTION

3.01 PREPARATION

A. Inspect existing conditions and note dimensions, clearances, access, utilities, shoring and protection required.

B. Have in place, before demolition begins, required protection measures, protective and regulatory devices, and personnel. Protective measures include barricades, warning and temporary routing signs, lights and similar devices.

C. Where an abutting structure or a part of a structure is to be left in place, make clean, smooth, vertical cuts with a saw or other approved cutting device to lines indicated. If not indicated or otherwise required, demolish structure to a minimum of 18 inches below subgrade.

D. The Contractor may salvage materials from demolition for use in temporary facilities but shall not use the salvaged materials in the Work unless approved in writing by the Engineer for each specific case, or unless specifically called for in the Contract Documents.

E. Obtain utility shut off to safely execute the work.

F. Verify that structures to be removed are cleared of utilities.

G. Provide temporary construction for the maintenance, support and protection of existing adjacent structures and facilities that are to remain.

3.02 DEMOLITION

A. General:

1. Perform work of this Section in conformance with Caltrans Standard Specifications Section 15, Existing Facilities.

2. Do not place demolished material or demolition equipment where it will create excessive loads on any structure.

3. If unforeseen obstructions are encountered, obtain instructions from the Engineer before proceeding with the work.

4. Promptly repair, restore or replace damage, disturbance, or impairment of existing facilities to remain.

5. Repair or replace items to remain or to be salvaged which are damaged during demolition to the satisfaction of the Engineer or private property owner(s).

6. Refer to Specification Section 20200, Track Removal and Salvage, for related requirements in regard to track demolition, as applicable.

B. Salvage:

1. Salvage existing facilities as shown on Contract Drawings and transport to location designated by Engineer within 30 miles of the work site.

2. Take necessary precautions to disconnect, remove, protect, transport, and store salvaged items in a manner that will prevent damage.

C. Removal:

1. Remove existing facilities as shown on the Contract Drawings.

2. Wet down concrete materials during demolition to prevent spread of dust and dirt. Do not use water in a manner that would cause damage or contaminate runoff. Refer to General Requirements Section 01560, Temporary Control, in regard to control or erosion and pollution prevention.

3. Fill below grade areas and voids resulting from removal of below-grade structures and utilities, and compact to indicated grade in accordance with Specification Section 02300, Earthwork.

4. Remove abandoned conduit, wiring and piping to the source of supply,

or Limit of Work.

5. Saw cut concrete or asphalt pavement to 3 inches depth, with saw designed for cutting pavements, prior to pavement removal. Cuts shall be straight and free of ragged edges.

6. Removal of yellow thermoplastic and yellow painted traffic stripes, pavement markings, and pavement markers will produce hazardous waste residue. Comply with Caltrans Standard Specifications, Section 14-11.12.

D. Disposal: Refer to GC7.15, Disposal of Material Outside of the Work Site.

1. Do not store or stockpile on Caltrain property material designated for disposal, except as indicated in the Contract Documents.

2. Removed items that are not scheduled or shown on the Contract Drawings to be salvaged or re-used shall become the property of the Contractor and shall be disposed of outside of the work site.

3. Keep the project area clear of refuse and rubbish, and maintain the area in a neat condition.

E. Relocation:

1. Remove and install existing facilities in a new location.

F. Reconstruction:

1. Remove and disassemble existing facilities as shown on the Contract Drawings and construct again at the existing location or a new location.

2. Provide new parts or alteration to the existing facility as required.

3. Protect items removed for reconstruction from damage during removal, disassembly and final construction. Repair or replace any damaged facilities.

G. Modification:

1. Modify existing facilities as indicated on the Contract Drawings.

3.03 PRESERVATION OF REFERENCE MARKERS

A. Refer to Specification Section 01050, Field Engineering. Make arrangements with the Engineer to replace any survey markers and monuments missing or damaged during construction.

B. Store removed markers and monuments during demolition work.

END OF SECTION

SECTION 02110
SITE CLEARING

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes specifications for clearing and grubbing. Perform site clearing in advance of grading and other construction operations.

1.02 REFERENCE STANDARDS

A. State of California, Department of Transportation, Standard Specifications (Caltrans)

1. Section 17-2 Clearing and Grubbing

1.03 SUBMITTALS

A. Site Clearing Plan: Indicate location and limits of clearing and grubbing, methods, equipment, procedures, safety and protection measures, and disposal sites.

1.04 DELIVERABLES

A. Submit copies of manifests showing delivery of disposed materials in accordance with permit conditions within 24 hours from time of delivery.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide temporary or permanent materials as required for the proper execution of the work of this Section.

PART 3 - EXECUTION

3.01 GENERAL

A. Perform site clearing in accordance with Caltrans Standard Specifications Section 17-2.

B. Maintain a clear site until covered by new work or until completion of the Work.

C. Clear, grub, prune, remove, and dispose of materials, including bushes, brush, trees, stumps, fallen timber, logs, roots, signs, rubbish, refuse, trash and debris as shown on the Contract Drawings, specified herein, and as required to perform the work of the Contract.

D. Refer to Section 01560, Temporary Controls, for requirements for storm water pollution prevention and dust control.

E. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing facilities indicated to remain in place. Protect existing facilities on adjacent properties as well as those on PCJPB property. Restore existing facilities damaged by the work to original condition to the satisfaction of the Engineer.

F. Refer to Section 02510, Utility Grade Adjustments, for specifications for raising and resetting existing frames, covers, and lids to meet new finish grade elevations.

G. Upon completion of site clearing work, Caltrain property and adjacent areas shall be neat, clean and in condition to receive subsequent work.

H. Carefully remove items to be salvaged, and store where required by the Engineer or where indicated in the Contract Documents.

3.02 LIMITS OF SITE CLEARING

A. Perform site clearing sufficient to perform the construction work shown in these Contract Documents. In addition, perform site clearing as follows:

1. Perform site clearing for track construction for a distance of 15 feet measured perpendicular from the centerline of track outward toward the right-of-way, or from the centerline to the right-of-way, whichever is less.

2. Perform site clearing to three (3) feet beyond the toe of new embankments.

3. Perform site clearing at grade crossings to a distance of not less than 100 feet in each direction of the approach to grade crossings, within the entire width of the right-of-way, unless otherwise indicated on the Contract Drawings.

3.03 CLEARING

A. Cut, remove and dispose of all timber, brush, fallen timber, stumps and rubbish except for trees or other vegetation that is designated for preservation on the Contract Drawings. Retain and protect from damage any trees and shrubs that are outside the limits of the required clearing.

B. Completely remove trees, stumps, shrubbery, and brush in areas where embankment will be placed.

C. Remove stumps and roots completely in excavation areas and under embankments where the original ground level is within 3.5 feet of subgrade or slope of embankments. In embankment areas, where the original ground level is more than 3.5 feet below the sub grade or slope of embankment, cut off trees, stumps, and brush to within 6 inches of the ground.

D. Do not start earthwork operations in areas where clearing and grubbing are not complete, except that stumps and large roots may be removed concurrently with excavation.

3.04 GRUBBING AND STRIPPING

A. Grubbing: Excavate, remove and dispose of all roots, stumps, and other vegetation to a minimum depth of 30 inches. Measured depth shall be from existing ground surface or new finished grade, whichever is lower. Leave ground surface in a condition suitable for stripping of topsoil.

B. Stripping: Excavate and remove topsoil (including any remaining vegetation) which is not classified as suitable fill material down to suitable fill material, except in plant bed areas. Salvage topsoil if required in the Contract Documents.

3.05 EXISTING TREES AND VEGETATION

A. Protect existing trees indicated to remain in place against cutting, breaking or skinning of roots, skinning and bruising of bark, smothering of trees by stockpiling building materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary fences, barricades or guards at dripline to protect trees. Trees within limits of contract work shall be watered as required by the Engineer.

B. When it is necessary to cut tree roots to provide room for new construction, cleanly saw tree roots over 1-1/2 inches diameter. Cover exposed roots with wet burlap to prevent roots from drying out.

C. Where trees or shrubbery designated to remain or those in areas outside the area indicated to be cleared and grubbed are damaged in the course of the Work, repair damage to or replace damaged existing trees and shrubbery to the Engineer's satisfaction.

3.06 EXISTING STRUCTURES AND PROPERTY

A. Obtain permission from the Engineer prior to removing signs, posts, catch basin frames and grates, and manhole frames and covers not indicated on the Contract Drawings for removal.

B. Protect existing structures and facilities not to be removed.

C. Store salvaged items in an orderly manner as directed by the Engineer.

D. Protect existing survey monuments. Refer to Section 01050, Field Engineering, for procedures for replacement of disturbed or damaged bench marks or monuments.

3.07 DISPOSAL

A. Disposal: Refer to GC7.15, Disposal of Material Outside of the Work Site.

1. Do not store or stockpile on Caltrain property material designated for disposal, except as indicated in the Contract Documents.

2. Debris and material that is not scheduled or shown on the Contract Drawings to be salvaged or re-used, shall become the property of the Contractor and shall be disposed of outside of the work site.

B. Keep the project area clear of refuse and rubbish, and maintain the area in a neat condition.

END OF SECTION

SECTION 02200
SUPPORT OF EXCAVATION

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes specifications for design and installation of excavation support.

B. Section also includes specifications for excavation support systems the design of which is indicated on the Contract Drawings, as applicable.

1.02 GENERAL

A. Refer to GC7.14, Trench Excavation Safety Plan, for basic requirements related to this Section.

1.03 REFERENCE STANDARDS

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

1. Manual for Railway Engineering

B. ASTM International (ASTM):

1. A36 Standard Specification for Carbon Structural Steel
2. A53 Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated, Welded and Seamless
3. A252 Standard Specification for Welded and Seamless Steel Pipe Piles
4. A328 Standard Specification for Steel Sheet Piling
5. A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
6. A572 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
7. A992 Standard Specification for Structural Steel Shapes

C. American Welding Society (AWS):

1. D1.1 Structural Welding Code - Steel

D. American Wood Preservers Association (AWPA):

1. U1 User Specification for Treated Wood

E. California Code of Regulations (CCR):

1. Title 8, Chapter 4, Subchapter 4, Construction Safety Orders

F. Caltrain Engineering Standards for Excavation Support Systems

G. State of California, Department of Transportation (Caltrans):

1. Trenching and Shoring Manual

1.04 DEFINITIONS

A. Railroad Zone of Influence: Refer to Caltrain Engineering Standards for Excavation Support Systems.

1.05 DESIGN CRITERIA

A. Temporary excavation support (shoring) shall conform to the requirements in the Caltrans Trenching and Shoring Manual and Caltrain Engineering Standards for Excavation Support Systems.

B. Excavations adjacent to active tracks: Excavations below the Zone of Influence Line indicated in the Contract Drawings shall be supported in accordance with Caltrain Engineering Standards for Excavation Support Systems. The Contractor may request a waiver of railroad loading requirements when excavations are less than 4 feet deep, less than 4 feet square in area and are not closer than 10 feet from the center line at the track.

C. Where physical conditions of design require the placing of excavation support closer than specified herein, the design shall be submitted to the Engineer for review and approval of a waiver.

D. When support of track or tracks is necessary during construction (that is shoring adjacent to active tracks), interlocking steel sheet piling adequately braced and designed to carry Cooper E-80 live load is required. Soldier piles and lagging will be permitted for supporting adjacent track or tracks only when required penetration of steel sheet piling cannot be obtained or when, if approved by the Engineer, steel sheet piling would be impractical to place.

1. Do not use soldier piles and lagging for any shoring system within Zone 1 and Zone 2 of the Railroad Zone of Influence.

E. The excavation support shall allow safe and expeditious construction of the permanent structure and shall be designed to carry the loads imposed upon it, including earth pressures, vehicular traffic loading, railroad loading, utility loads, loads from adjacent structures, ground water pressure, equipment and construction loads, without movement or settlement of adjacent structures, utilities, or tracks.

F. Design splices in structural steel members to develop 100 percent of the strength of the member.

G. Cover excavations. Protect excavations by handrails, barricades, and warning lights.

1.06 SUBMITTALS

A. Excavation Shoring Systems: Submit the following showing the proposed methods of construction, design, and details:

1. Detailed working drawings for temporary shoring including the following: Plans, elevations, sections and details that clearly describe the systems to be installed to include the methods and procedures of installation to be followed and a description of each material to be employed. Dimensions and spacing of members shall be clearly noted. Include existing utility locations and temporary supports for utilities.

2. Design calculations including temporary shoring elements, and affected structure(s), demonstrating that the required design parameters have been met.

3. Product data for materials and equipment.

B. For Owner-Designed Excavation Shoring Systems, as Applicable: Submit the following:

1. Shop drawings showing excavation support elements, including layout of piles and bracing elements. Identify and show location of existing utilities in both plan and elevation.

2. Include details showing how the excavation support system will be installed around utilities.

3. Design of temporary supports for utilities to be maintained across the excavations.

C. Submit the following as applicable to specific support systems:

1. Construction and installation procedures, excavation sequence, interface details, protection measures for existing structures and facilities, and contingency plans for excessive movement of existing walls and other facilities.

2. Concrete mix designs as specified in Section 03300, Cast-in-Place Concrete.

3. Soil-cement design mixes, including test data demonstrating that the proposed mixes will meet required strength.

4. Quality control/quality assurance plan for soil-mix wall construction. Coordinate with Section 01400, Quality Control and Assurance, suitable for demonstrating that the soil-mix walls have been installed to the required depths and dimensions and will have the required strength, continuity, and permeability at the time of excavation. Include the means of continuously monitoring the slurry injection process during soil

mixing, soil-cement sampling methods and frequency, and soil-cement testing methods and frequency.

D. Submit instrumentation and monitoring plan that includes the following information:

1. Drawings showing planned locations and identification numbers for each settlement point, railroad settlement point, and monitoring well.

2. Proposed schedule for installing and for monitoring settlement points, railroad settlement points, inclinometers, and monitoring wells.

3. Descriptions and details for methods and materials to be used in the installation of settlement points, railroad settlement points, inclinometers, and monitoring wells.

4. Manufacturer's literature including product descriptions, and operation and maintenance procedures for instruments.

5. Details for abandoning instruments at the completion of the Work.

E. Submit as-built drawings of instrumentation installation within 5 days of completion of instrument installation.

1.07 DELIVERABLES

A. Submit written confirmation stamped and signed by a professional civil engineer in the State of California that the shoring systems have been constructed in accordance with the approved submittals.

B. Submit the following as applicable to specific support systems:

1. Deliverables specified under Section 05200, Structural Steel.

2. Soil-cement testing results within 3 days of tests being performed.

3. Instrument readings within 3 days of the readings being taken.

1.08 QUALITY ASSURANCE

A. Temporary Shoring:

1. Temporary shoring designs including working drawings and calculations shall be prepared, stamped, and signed by a professional civil engineer hired by the Contractor who is currently registered in the State of California, has previous experience in the design of temporary shoring systems, and is qualified as required in the Caltrain Engineering Standards for Excavation Support Systems.

2. Contractor's State of California registered professional civil engineer for the shoring design shall inspect the as-built shoring system to verify that the system is constructed in accordance with the approved shoring plans. The number of site visits and the stage or stages of construction

at which they shall be performed shall be as required by the Engineer as a condition of approval of the shoring system.

3. Maintain sheeting, bracing and other temporary protective work in place and functioning until temporary protective work is no longer necessary, as determined by the Contractor's State of California registered professional civil engineer.

B. Track Monitoring:

1. Railroad tracks shall be monitored in accordance with the requirements outlined in Caltrain Engineering Standards for Excavation Support Systems.

2. Surveying for monitoring settlement points shall be performed by a Land Surveyor hired by the Contractor licensed who is currently registered in the State of California with previous experience surveying for the detection of structural or ground surface movements.

C. Structure(s) shall be monitored per the Contract Documents and Caltrain Standard.

D. Comply with the following regulatory requirements:

1. CCR, Title 8, Chapter 4, Subchapter 4, Construction Safety Orders.

1.09 CONTRACTOR ALTERNATIVES

A. Where excavation support systems and details are shown on the Contract Drawings, the Contractor may propose alternate systems and details provided such systems meet the design requirements and criteria specified herein and shown on the Contract Drawings and the limitations on shoring types specified herein.

B. Alternate excavation support systems and details shall be submitted for the Engineer's approval as specified herein for Contractor-designed excavation shoring systems.

C. Should the Contractor choose to modify the shoring system, the Contractor does so at the Contractor's own risk and no claims for additional time or compensation will be allowed as a result of any delays or difficulties suffered.

PART 2 – PRODUCTS

2.01 TEMPORARY SHORING MATERIALS

A. Materials for temporary shoring systems may be new or used, provided they are sound and free from any strength-impairing defects.

B. Materials shall conform to the following specifications as shown on the approved submittals for Contractor-designed systems or as indicated on the Contract Drawings:

1. Structural, Plate, and Tube Steel: ASTM A36, A500, A572, or A992

2. Steel Sheet Piling: ASTM A328 or A572

3. Steel Pipe: ASTM A53 or A252

4. Concrete: As specified in Section 03300, Cast-in-Place Concrete, and shown on the Contract Drawings or in the approved submittals. Lean concrete strength shall be so proportioned that the concrete retains its shape during excavation operations.

5. Timber Shoring Elements: Douglas Fir, No. 2, or better. Timber to remain permanently in place shall be pressure-treated with preservative material in accordance with AWPA U1, User Category UC4B or UC4C.

2.02 INSTRUMENTATION AND MONITORING MATERIALS

A. Settlement Points: For paved areas: An inscribed marking of approved surveyor's nail driven flush with the pavement surface. For unpaved areas, two (2) by two (2) inch timber stake (hub) driven flush with the ground. Each settlement point shall have an identification tag or marking.

B. Inclinometer shall consist of the following:

1. Inclinometer Casing: A special purpose grooved casing used in inclinometer installations. Casing manufactured by Slope Indicator Company, Geokon, Inc., or Engineer approved equal, including accessories necessary for installation as recommended by the manufacturer. Provide locking cap with padlock for each installed casing.

2. Inclinometer Probe: Digitilt Inclinometer Probe manufactured by Slope Indicator Company, Model 6000 Inclinometer Probe manufactured by Geokon, Inc., Engineer approved equal, including cable, pulley assembly, case and any other necessary accessories.

3. Readout Unit: Digitilt DataMate manufactured by Slope Indicator Company, Model GK-603 Inclinometer Readout manufactured by Geokon, Inc., or Engineer approved equal.

4. Software: Computer software required to reduce, to analyze, and to plot inclinometer data.

5. All inclinometer materials and equipment shall be compatible with all other inclinometer materials and equipment.

C. Monitoring Wells: Provide monitoring well materials in conformance with Contractor's approved instrumentation and monitoring plan. Provide an instrument suitable for the purpose of determining the groundwater elevation in the monitoring well.

PART 3 - EXECUTION

3.01 PREPARATION

A. Implement Instrumentation and Monitoring Program including establishing railroad settlement points by marking locations on the track using means acceptable to the Engineer.

B. Prior to placing and driving steel piles or sheeting, hand dig exploratory trenches in areas where railroad underground installations are known to exist. Backfill these trenches immediately after the exploratory work is finished. Perform this work in the presence of the Engineer.

C. Coordinate support of excavation with dewatering specified in Section 02210, Dewatering, as applicable.

3.02 TEMPORARY EXCAVATION SUPPORT SYSTEMS

A. Fill cavities adjacent to the excavation support system created by driving of sheet or soldier piling with sand.

B. Unless otherwise noted or directed, all components of the support system shall be removed as the backfill is being placed.

C. Immediately restore and tamp any ballast disturbed during construction of excavation support systems.

D. Remove any bracing tieback anchors or other support devices that are exposed.

E. Immediately fill all voids created by the excavation support members with lean concrete or sand.

F. Perform final backfilling of excavations in accordance with Section 02300, Earthwork.

G. Perform welding in accordance with the provisions of AWS D1.1.

H. Splices in structural steel members shall develop 100 percent of the strength of the member.

I. Maintain sheeting, bracing and other temporary protective work in place and functioning until temporary protective work is no longer necessary. Refer to quality assurance requirements specified herein.

J. If, at any time, existing or new construction, tracks, utilities, or similar facilities appear to be endangered, provide additional support measures to such facilities, subject to approval of the Engineer. Provide additional bracing or shoring if considered necessary by the Engineer to safeguard against and prevent movement or settlement.

K. During construction, cut off sheet piling at the elevation of the top of adjacent tie. After construction and backfilling has been completed, remove sheet piling

completely unless otherwise required by the Engineer or indicated in the Contract Documents.

L. Protect track ballast against contamination. Replace contaminated ballast.

M. Prevent settlement points from being damaged during construction.

END OF SECTION

SECTION 02210
DEWATERING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for temporary dewatering systems.

1.02 SYSTEM DESCRIPTION

A. Remove water which accumulates in excavations during the progress of work so that all work can be done in the dry, unless otherwise approved by the Engineer. Keep excavated areas free from water while underground utilities or structures are constructed, while concrete is setting and until backfill or elements of the structure have been placed to a sufficient height to anchor the work against possible leakage or buoyant uplift forces. A height to anchor the work against buoyant uplift forces shall be considered sufficient when the dead load weight of the backfill or elements of the structure exceeds the uplift forces by a minimum factor-of-safety of 1.5.

B. In addition to the other requirements specified herein, design the dewatering systems to perform as follows:

1. Prevent damage to adjacent properties, buildings, structures, utilities, and other work as a result of settlement or other groundwater-related effects.

2. At all times, maintain groundwater levels over the entire excavation a minimum of 3 feet below the excavation grade within the shoring system.

3. Maintain stability of excavated slopes and the bottom of excavation.

C. At all times, have on the work site sufficient pumping equipment for immediate use, including standby pumps for use in case other pumps become inoperable. Dispose of water in accordance with the detailed requirements specified herein and so as to cause no injury to personnel or the public, damage to public or private property, nor menace to public health.

D. Design dewatering system to prevent pumping fines from below grade or disturbing materials exposed at the excavation bottom. Wells shall be cased, and filter(s) shall be provided to prevent such pumping of fines.

E. Provide a sufficient number of monitoring wells to confirm the following:

1. The dewatering system is performing as intended and is achieving the specified reduction in groundwater levels.

2. Construction site groundwater levels inside and outside dewatered excavations to determine the acceptability of removing the dewatering

system from operation.

F. Furnish container for construction dewatering complete with baffles for the purpose of filtering silt prior to discharge of water. Size container or containers to suit dewatering and storage demands.

G. If the approved methods include displacing groundwater as concrete or other work is placed in excavations, the dewatering system shall capture groundwater as it is displaced and follow the procedures herein for its containment, analysis, and discharge.

H. Obtain jurisdictional authority's specific discharge requirements prior to commencement of dewatering.

I. All accumulated groundwater must be containerized and tested for analytes including petroleum hydrocarbons, volatile organic compounds, and heavy metals prior to disposal or discharge. Disposal or discharge may require special permits and applications (NPDES and POTW) for appropriate management.

1.03 SUBMITTALS

A. Submit dewatering plan including shop drawings and design data including the following elements:

1. The proposed type of dewatering system.

2. Arrangement, location, and depths of system components.

3. Complete description of equipment and instrumentation to be used, with installation, operation and maintenance procedures.

4. Types and sizes of filters.

5. Design calculations demonstrating adequacy of the proposed system and equipment.

6. Methods of disposal of pumped water.

7. Method of water quality monitoring.

8. Type of filtration and chemical treatment of contaminated water, as applicable.

9. Well point system design, if proposed: Submit design complete with calculations and shop drawings.

10. Method for establishing and monitoring construction site groundwater levels.

11. Criteria for determining the acceptability of removing the dewatering system from operation.

B. Prior to removing the dewatering system from operation, submit documentation

and calculations verifying that the approved criteria for determining the acceptability of removing the system from operation have been met.

1.04 DELIVERABLES

A. Submit copies of permits required for work of this Section.

1.05 QUALITY ASSURANCE

A. Well point design, if applicable, shall be prepared, signed, and sealed by a geotechnical engineer registered by the State of California and qualified and experienced to perform such design.

PART 2 – PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 DEWATERING

A. Except as otherwise indicated in the Contract Documents, perform dewatering to accomplish a lowering of measured static ground water level to an elevation which is suitable for the construction of structures below grade.

B. When pumping is required to reduce groundwater levels, accomplish pumping in a manner that will not disrupt the surrounding environment.

C. Refer to GC7.9, Sound and Light Control Requirements, for noise control requirements. The Contractor may, during the daylight hours of 8:30 AM to 4:30 PM, use power plants to operate the dewatering pumps. During all other hours, power to run the pumps shall be electric and obtained from the electric power utility in accordance with Section 01590, Construction Facilities, unless otherwise authorized by the Engineer and jurisdictional authorities.

D. If any dewatering well pumps fines, terminate pumping and construct new well at a different location with a revised design which eliminates the pumping of fines.

E. Do not turn off the dewatering system in a manner that the upsurge in water weakens the subgrade for completed excavation and structure foundation work.

F. Remove storage containers, including those cleaned, and other dewatering facilities from the site at the completion of dewatering operations.

3.02 CONTAINMENT, ANALYSIS, AND DISCHARGE OF GROUNDWATER EXTRACTED

A. Containment: Upon extraction, store groundwater extracted in the process of construction dewatering in containers prior to discharge or disposal of water, as applicable. Keep containers locked to prevent accidental or purposeful discharge of the water. Contain and store the water on-site and in such a manner that it will not interfere with the Contractor's existing or continued construction operations.

B. Analysis: Collect and analyze water samples taken directly from each storage container to verify that the extracted groundwater meets applicable discharge requirements. Number of samples taken per container shall be at the sole discretion of the Engineer.

C. Discharge Requirements: Discharge no water which exceeds regulatory requirements or the jurisdictional authority's discharge requirements.

D. Discharge: Obtain jurisdictional authority's specific discharge requirements prior to commencement of dewatering. Subject to the discharge restrictions specified herein and upon written authorization from the jurisdictional authority, discharge effluent from dewatering directly into existing sanitary manholes, where said sewer system is in operating condition. Provide conduits to carry said effluent to nearest sanitary sewer manhole and drainage to the nearest storm drainage. Confirm that manholes to be utilized are in operating condition. Release water in a manner that will not impact the Contractor's operations.

E. Disposal: In the event that extracted groundwater does not meet the discharge requirements criteria, provide for the disposal of the extracted groundwater in accordance with GC7.15, Disposal of Material Outside of the Work Site. Clean dewatering containers, piping, pumps, and other dewatering facilities contaminated as a result of the Work.

F. Use: Extracted groundwater of sufficient quality as shown by test data may be used on site with Engineer's written approval for those purposes approved by the Engineer.

END OF SECTION

SECTION 02245
HORIZONTAL DIRECTIONAL DRILLING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section Includes: Requirements for Horizontal Directional Drilling (HDD) of utility piping and casings.

1.02 QUALITY ASSURANCE

A. Experience: The operator shall be actively engaged in horizontal directional drilling for a minimum of 3 years.

B. Field supervisory personnel: Experienced in the performance of the work and tasks as stated herein for a minimum of 3 years.

1.03 SUBMITTALS

A. Submit the following for information only.

1. Presentation of similar experience in the last 3 years.

2. Include, but not limited to, owner name, address, telephone number, contact person, date and duration of work, location, pipe information, and contents handled by pipeline.

3. Supervisory field personnel and historical information of HDD experience. At least one of the field supervisors listed must be at the site when HDD operations are in progress.

B. Submit the following for approval:

1. Working Drawings and written procedure describing in detail proposed method and entire operation including, but not limited to:

a. Size, capacity, and arrangement of equipment.

b. Location and size of drilling and receiving pits.

c. Dewatering and methods of removing spoils material.

d. Method of installing detection wire and pipe.

e. Type, location, and method of installing locator station.

f. Method of fusion pipe segment and type of equipment.

g. Type of cutting head.

h. Method of monitoring and controlling line and grade.

i. Method for detection of surface movement.

j. Bentonite drilling mud:

1) Products information, material specifications, and handling procedures.

2) Safety Data Sheet (SDS) and special precautions required.

3) Method of mixing and application.

2. Support of excavation for pits: Submit the proposed methods of construction, design, and details for pit excavation shoring systems. Refer to Section 02200, Support of Excavation, for related submittals for support of pit excavation.

3. Emergency remediation plan:

a. Identify methods to cut and remove rock, concrete, or timber encountered at the boring face and methods to temporarily bulkhead the face.

b. Identify remedial measures for limiting damage to existing facilities, impact to tracks, and railroad operations due to ground settlement.

c. The Contractor must have the resources to execute this plan immediately available.

4. Submit product data including catalog cuts and other descriptive data.

1.04 DELIVERABLES

A. Submit copies of test reports for material properties and compaction as required in this Section.

B. Record (As-Built) Drawings: As-built survey drawing of completed installation including horizontal and profile drawings.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Pipes

1. Pipes used shall meet requirements specified in AREMA Chapter 1, Part 5 Utilities. Submit material specifications and vendor data for pipes for approval.

2. HDPE or PVC Joints:

a. Use butt fusion joining technique for joining pipe segments installed by HDD.

b. When joining HDPE OR PVC pipe at ends of directional drilling runs fusion bond to the adjacent pipe section. Use butt fusion, socket fusion, or electrofusion coupling joining technique.

c. Mechanical Couplings are not permitted for joining of directional drilled pipe sections.

B. Drilling Fluid.

1. Bentonite drilling fluid compatible with the environment.

2. Waste oil or environmentally non-compatible polymers shall not be a part of the composition.

C. Detection Wire.

1. TW, THW, THWN, or HMWPE insulated copper, 10 gage or thicker wire.

D. Locator Station.

1. Underground, Flush Mounted:

a. Tube, minimum 15 inches long with minimum inside diameter of 2-1/2-inches made of non-corrosive material, schedule 40 PVC, HDPE OR PVC, or equal.

b. Factory attached cast iron or high-impact plastic collar with ribs to prevent rotation when removing locking lid after locator station is set in concrete.

c. Light blue cast iron or high-impact plastic locking lid that will withstand AASHTO H-20 traffic loads and ultra-violet rays.

d. Mark locking lid to identify pipeline with a permanent identification such as P.S. Locator.

e. Terminal block made of a high dielectric material which is made of phenolic resin, plastic, micarta, Lexan or Bakelite for each locator station.

1) Terminal block furnished with two 3/16-inch threaded studs, nuts, and washers made of nickel plated brass.

f. Manhole Mounted:

1) Waterproof enclosure made from cast aluminum, galvanized steel, high impact plastic, Lexan, Gyrlyn, or equal.

2) Light blue schedule 40 PVC pipe or schedule 40 galvanized steel with an outside diameter of at least 3/4-inch to mount enclosure.

3) Use similar materials for pipe and enclosure to fasten enclosure onto pipe following manufacturer's instructions.

PART 3 – EXECUTION

3.01 PREPARATION

A. Excavate pits following the working drawings approved.

B. Provide equipment to guard against electrocution and an alarm system on drilling equipment capable of detecting electrical current as it approaches electric lines.

3.02 OPERATION

A. General.

1. Determine drilling length and equipment pull strength for type of soil encountered.

2. Provide method to control line and grade.

a. Provide and maintain instrumentation that accurately locates pilot hole.

b. Drill pilot hole along path following Drawings to these tolerances:

1) Vertical alignment plus or minus 0.5 foot. Vertical path of the pilot hole must not establish new high points not shown on Drawings.

2) Horizontal alignment plus or minus 1.0 foot.

c. Include electronic monitoring of the horizontal and vertical drilling head location. Obtain an accuracy range within 1 inch of actual position of the pipeline. Record position readings at a maximum of 10 foot intervals.

d. At completion of pilot hole drilling, furnish Engineer tabulations of horizontal and vertical alignment.

3. When water is encountered.

a. Provide and maintain a dewatering system of sufficient capacity to remove water.

b. Keep excavation free of water until backfill operation is in progress.

c. Perform dewatering in such a manner that removal of soils particles are held to a minimum.

d. Dewater into a sediment trap following Section 02210, Dewatering.

4. Maintain close observation to detect settlement or displacement of surface and adjacent facilities.

a. Notify immediately if settlement or displacement is detected.

b. Act to maintain safe conditions and prevent damage.

B. Drilling Operation.

1. Drilling Fluids.

a. Maintain drilling fluid in bore hole to increase stability of the surrounding soil and reduce drag on pulled pipe.

b. Dispose of drilling fluid and other spoils at location following laws, ordinances, rules, and regulations of local jurisdiction.

c. Transport excess fluids and other spoils to the disposal site, at no additional cost to the Commission.

d. Minimize drilling fluid at locations other than entry and exit points. Immediately clean up any drilling fluids that inadvertently surface.

e. Provide clean water for drilling.

2. Pilot Hole Drilling.

a. Angle entry hole so that curvature of pilot hole does not exceed allowable bending radius of pipe used.

b. Be able to make a turn of up to 90 degrees and maintain a curvature not to exceed allowable bending radius of pipe used.

c. Alignment Adjustment and Restarts.

1) Follow pipeline alignment on Drawings within tolerances specified herein.

3. Keep the number of boring pits to a minimum, no closer than following distances, unless otherwise approved.

4. Equipment must be capable of boring following lengths in a single bore:

Iron Pipe Size (IPS)	Boring Distance (In feet)
1-1/4	400
1-1/2	400
2	350
2-1/2	350
3	300
4	250

3.03 INSTALLATION

A. Installing Pipe:

1. Provide a swivel to reaming assembly and pull section of pipe to minimize torsional stress on pull section after drilling pilot hole.

2. Hold reaming diameter to 1.5 times the outside diameter of the pipe being installed.

3. Protect pull section as it proceeds during pull back so that it moves freely and is not damaged.

4. Pull detection wire along with the pipe to be installed. Extend wire into locator station at each end of the pipe.

5. When connecting to adjacent pulled or non-pulled section of the pipe installed, allow pull section of pipe to extend past termination point. Make tie-ins the next day after pullback of the pipe installed.

B. Installing Locator Station:

1. Locator Stations

   a. Provide locator stations, following the working drawings approved, at each end of the pipe installed.

   b. Flush mount underground locator.

   c. When pipe is connected to another type of pipe material, continue detector wire over the connecting pipe, so locator station is installed out of paved area.

2. Detection Wire

   a. Install detection wire without splices.

   b. Terminate detection wire inside locator box using proper sized crimp type connectors on wire ends.

   c. Connect each wire to a terminal maintaining at least 18 inches slack in each wire for underground flush mounted locator stations.

d. Neatly coil slack wire in test station below terminal board.

e. Locate wires on top and along the pipe installed.

f. Allow adequate slack and support to protect wires from damage during backfilling operations.

g. Test each detection wire for continuity after backfill is completed.

1) If test for continuity is negative, repair or replace at the Engineer's direction.

2) After continuity is verified, connect each detection wire to terminal block in locator station.

C. Maintain a daily project log of boring operations and a guidance system log with a copy given to Engineer at completion of project. Provide accurate As-Built data based on downhole survey data or a walkover location system that indicates x, y and z coordinates of the pipe at least every ten (10) feet along the alignment. As-built drawings shall be certified as to accuracy by Contractor.

END OF SECTION

SECTION 02300
EARTHWORK

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes specifications for earthwork including excavation, trench excavation for underground utilities, ballast and subballast removal, placement of backfill, and construction of embankments. Section also includes requirements for placement of detectable tape for underground utilities.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. C131 Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

2. C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

3. D1556 Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method

4. D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))

5. D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

6. D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

7. D3740 Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as used in Engineering Design and Construction

B. State of California, Department of Transportation, Standard Specifications (Caltrans):

1. Section 19 Earthwork

1.03 DEFINITIONS

A. Soil Classification: Soil classification is based on the Unified Soil Classification system given in ASTM D2487. Group symbols, when used, conform with the symbols of ASTM D2487.

B. Existing Ballast: Granular material in areas of existing tracks, between top of tie and existing subgrade. The depth of existing ballast varies.

C. Degree of Compaction: A percentage of the maximum density obtained by the test procedure presented in ASTM D1557, Method C.

D. Structure Excavation and Backfill: Refer to Caltrans Section 19-3 Structure Excavation and Backfill 19-3.01A Summary.

1.04 SUBMITTALS

A. Submit plans and procedures for approval prior to commencing work for rough grading, temporary storage area(s) for topsoil, excavation, embankment Fill, structure excavation and backfill, subgrade preparation, borrow and removal of unsuitable materials.

B. Submit the following pothole shop drawings when specifically required in the General Requirements. Submit shop drawings of potholed pipes, sewers, utilities and other facilities a minimum of two (2) weeks before beginning shoring excavation or underground construction. Show survey information at each location, and accurately establish the size, location, elevation, and alignment of the facility as well as the existing grade elevations in the vicinity of the potholes. Include the bearing of the facility alignment, coordinates at the centerline of the facility for pipelines, and the coordinates of the corners of boxes, manholes, and other similar types of facilities. Label pertinent information relating to the bent, column, footing, track alignment, and other proposed improvements including new or relocated underground facilities (waterline, sewer, storm drain, combined system duct bank, and underdrain). Include footing dimensions, bent skew, stationing, column offsets, and footing elevations. Proceed with no trenching, excavation, or shoring work until the Engineer has accepted potholing shop drawings. Shop drawings shall be prepared at 1:20 or 1:60 scale, sufficient to show the following information:

1. Topography

2. The entire bent and footings

3. Columns adjacent to the potholes

4. The track alignment

5. Other proposed improvements in the vicinity that might be affected by the location of the existing pipe, sewer, utility or other facility

1.05 DELIVERABLES

A. Submit copies of test reports for material properties and compaction as required in this Section.

1.06 QUALITY ASSURANCE

A. Inspection and Testing Agency retained for inspection and testing specified in this Section shall meet the requirements of ASTM D3740.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Embankment fill and backfill shall consist of suitable material from project site excavation or off site borrow meeting the following requirements:

1. Material shall be free from organic matter, excessive fines, or unsuitable products of demolition. Fill and backfill shall contain no rocks or lumps over 3 inches in greatest dimension within 1 foot of the top of subgrade.

2. Material shall have plasticity index of 15 or less and a liquid limit of 30 or less and expansion index of 30 or less, except where otherwise approved by the Engineer.

3. Material shall have plasticity index of 15 or less and a liquid limit of 30 or less and expansion index of 30 or less, except where otherwise approved by the Engineer.

4. Suitable fill materials may be obtained from on-site excavation and rough grading operations provided the Contractor submits laboratory test results demonstrating that the materials meet or exceed the criteria established in this Section. If sufficient suitable materials are not available to meet requirements, the material shall be obtained from outside sources.

5. Materials from on-site excavations, which may otherwise be suitable for use as fill, may contain excess moisture in their natural state, or may take on excess moisture during handling and stockpiling that would render them unsuitable for use as fill. The Contractor must dry the material as necessary as specified in the Section entitled "Moisture Control" herein to attain the required minimum standard, at no additional expense to the Owner.

6. Nesting of rock pieces that will create voids will not be permitted.

7. Materials not meeting these requirements are classified as unsuitable and shall be legally disposed off-site by the Contractor unless directed otherwise by the Engineer.

B. The following materials shall be as specified in the respective Sections of the Caltrans Standard Specifications, except as otherwise indicated:

1. Structure Backfill: Caltrans Standard Specification Section 19-3.02C, Structure Backfill

2. Pervious Backfill: Caltrans Standard Specification Section 19-3.02D, Pervious Backfill Material

3. Slurry Cement Backfill: Caltrans Standard Specification Section 19-3.02E, Slurry Cement Backfill

C. Soil Stabilization Geotextile: Subgrade enhancement geogrid must be biaxial geogrid such as Tensar Bi-Axial Geogrid or Engineer approved equal. A polyester geotextile must not be used for subgrade enhancement geotextile within 4 inches of recycled concrete.

D. Bedding Material for Culverts, Pipes, and Utilities: Conform to Caltrans Standard Specification Section 19-3.02F, Sand Beddings.

E. Underground Warning or Detectable Tracer Tape: Terra Tape Reinforced Sentry-Line as manufactured by Reef Industries, or Engineer approved equal. Extra stretch is acceptable if Reinforced type is not available for the color. Uniform color code (per APWA) as follows:

Identification	Type	Color
Gas Line	12” wide Reinforced	Yellow
Water Line	6” wide Reinforced	Blue
Electrical Line	12” wide Reinforced	Red
Sewer, Drain, Irrigation Line	6” wide Reinforced	Green
Fiber Optics, Signal, Communications Line	12” wide Reinforced	Orange

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. Existing Underground Lines and Services: Remove or abandon in place unclaimed, abandoned utilities as indicated on the Contract Drawings.

B. Utilization of Excavated Materials: Use material removed from excavations for backfill, embankment, subgrade, and similar purposes, unless the material is unsatisfactory. Refer to Article entitled “Excess Material” herein for disposal of excess materials.

C. Erosion Protection: Refer to Section 01560, Temporary Controls, for storm water pollution prevention, dust control, and related requirements. Protect exposed graded areas from wind and water erosion until stabilization is achieved.

D. Perform dewatering as necessary. Refer to Section 02210, Dewatering.

E. Use Soil Stabilization Geotextile for soil stabilization where indicated in the Contract Drawings.

3.02 EXCAVATION

A. Excavate material encountered within the limits of the work, to the lines, grades, and elevations as indicated on the Contract Drawings and as specified herein.

1. In areas where track is to be constructed in the location of an existing track, excavate to the subgrade indicated on the Contract Drawings or bottom of existing ties, whichever is lower.

B. General construction excavation shall not exceed 1 vertical to 1 horizontal slope. If this cannot be accomplished, provide temporary shoring, sheeting and bracing as necessary to retain excavations, maintain banks securely, withstand water pressure, and prevent cave-ins in accordance with Section 02200, Support of Excavation.

C. Perform excavation and placement of fill in a manner and sequence that will provide proper drainage at all times.

D. Surfaces shall be level, or sloped if required, clean, and clear of loose soil. Maintain in good condition until overlying materials are placed.

E. Perform measures to correct over-excavation due to error or careless excavation procedures.

F. Perform structure excavation in accordance with Caltrans Standard Specifications, Section 19-3, Structure Excavation and Backfill.

G. Maintenance of Excavation: When backfill is placed, remove sheeting and bracing in stages so that the walls are supported by the shoring or by newly placed backfill.

3.03 BACKFILL (GENERAL)

A. Place backfill in layers not to exceed 8 inches of loose material, and compact each layer to at least 95 percent laboratory maximum density, in such a manner as to prevent wedging action or eccentric loading.

B. Backfill excavations when installations have been completed, inspected, and approved. Ensure that the following conditions are satisfied prior to proceeding with backfill operations:

1. Concrete has attained sufficient strength to withstand pressure of earth and compacting operation.

2. Excavations are free of forms, debris, and other foreign materials.

C. Place structure, pervious, and slurry cement backfill as specified in the following respective Sections of the Caltrans Standard Specifications, except as indicated otherwise:

1. Structure Backfill: Caltrans Standard Specification Section 19-3.03E, Structure Backfill

2. Pervious Backfill: Caltrans Standard Specification Section 19-3.03G, Pervious Backfill Material

3. Slurry Cement Backfill: Caltrans Standard Specification Section 19-3.03F, Slurry Cement Backfill

3.04 BACKFILL, BEDDING AND FILL FOR CULVERTS, PIPES, AND UTILITIES

A. Bottom of Trench Compaction. Bottoms of excavations shall be firm, undisturbed earth or cut subgrade, clean and free from loose materials, debris, and foreign matter. When bottoms of excavations or trenches are a soft or unstable materials, make bed firm and solid by removing said unstable materials to a sufficient depth and replace same with sand or pea gravel, and compact to a minimum of 90 percent relative compaction. If during construction, soft soils are encountered at depths that make removal impractical, notify the Engineer.

1. Refer to Section 02650, Precast Concrete Culverts, for specific requirements for precast culvert trenches. Refer to Section 15550, Storm Water Lift Stations, for specific requirements for precast vault manhole for pump station.

B. Bedding and Backfill Around Pipes:

1. Before the initial layer of bedding is placed, tamp the bottom surface of the trench or compact bottom surface by plate or other means to provide a base for the bedding.

2. Before the pipe or conduit is laid, place and compact bedding material in conformance to the provisions in Caltrans Standard Specification Section 19-3.03H, Culvert Beddings. Do not use jetting.

C. Unless specified elsewhere, backfilling for underground utilities shall comply with the following:

1. Replace any unsuitable material with approved backfill material and compact as specified herein. Approved backfill material shall include:

   a. Native excavated material approved by the Engineer

   b. Salvaged track ballast approved by the Engineer

   c. Imported Backfill approved by the Engineer (if native material or reclaimed track ballast is not available)

2. Place and compact initial lifts in six (6) inch layers maximum uncompacted thickness until 12 inches over pipe. Subsequent lifts may be up to 12 inches in depth prior to compaction. Bring up uniformly on both sides of pipe.

3. Compact foundations for underground utilities and associated structures to not less than 95 percent of the maximum density as determined by ASTM D1557.

4. Place tracer tape (detection tape) one foot above new and recently exposed buried utilities including conduits, fiber optics, communication and signal cables, gas lines, petroleum lines, water lines, and electrical lines. Lay tape flat with three foot of overlap at the end of rolls. If tracer tape depth will exceed tape manufacturer's recommendation, obtain additional instructions from the Engineer before proceeding.

D. Place and compact structure backfill at culverts as specified in this Section under Backfill (General) and as follows:

1. When the level of fill reaches the top of the structure, spread and hand compact two lifts over the structure without traversing the structure with heavy equipment. Begin no compaction with heavy equipment until a minimum of two lifts have been placed, hand compacted, and tested.

2. Back and compact backfill to the same elevation on both sides of the culvert before proceeding to the next layer.

3. When the height of cover indicated on the approved shop drawings or Contract Drawings, as applicable, is 12 inches or less, backfill structure with slurry cement backfill to the top of the structure.

4. In regard to precast concrete culverts, operate equipment over the culvert in accordance with the culvert manufacturer's recommendation.

E. Keep construction equipment away from edges of excavation a distance equal to the depth of the excavation.

F. Do not place stones larger than 3 inches in backfill around pipes.

G. Refer to compaction and field quality control requirements specified herein for additional requirements.

3.05 EMBANKMENTS

A. Clear and grub ground surface on which embankment fill is to be placed of live, dead, or decayed vegetation including trees; rubbish; debris; and other unsatisfactory material in accordance with Section 02110, Site Clearing.

B. Scarify prepared ground surface and moisten or aerate as required just prior to placement of embankment materials to ensure bond between embankment material and the prepared ground surface.

C. Construct earth embankments from approved backfill material. Place material in successive horizontal lifts of loose material not more than 12 inches in depth. Prior to placement of each layer, moisten or aerate soil surface as necessary and scarified or otherwise broken up in such a manner that the fill will bond with the surface on which it is placed. Uniformly spread layer. After spreading each layer, plow, disk, or otherwise break up layer; moistened or aerated as necessary; thoroughly mix; and compact to at least 90 percent laboratory maximum density if more than two (2) feet below subgrade elevation, and 95 percent if within two (2) feet of subgrade elevation.

3.06 GRADING

A. Grading shall conform to the Contract Drawings and the tolerances specified herein. Transport satisfactory excavated materials to and place in fill or embankment within the limits of grading work. Excavate unsatisfactory materials encountered within the limits of the work and replace with satisfactory materials.

Remove unsatisfactory materials and dispose of as specified in the Article entitled "Excess Materials" herein.

B. Finish the surface of excavations, embankments, and subgrade to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown on the Contract Drawings. Finish grade to within 1/2 inch of the grades and elevations indicated. Finish ditches in a manner that will result in effective drainage.

C. Preparation of Subgrade: Shape subgrade to line, grade, and cross section, and compacted as specified. Shaping subgrade shall include plowing, disking, scarifying existing track subgrade and moistening or aerating required to obtain specified compaction. Remove soft or otherwise unsatisfactory material and replace with satisfactory excavated material or other approved material as directed. Bring low areas resulting from removal of unsatisfactory material up to required grade with satisfactory materials, shape entire subgrade to line, grade, and cross section, and compact as specified. After rolling, the surface of the subgrade shall not show deviation greater than 1/2 inch when tested with a 10-foot straightedge applied both parallel and at right angles to the centerline of the area.

D. Protection and Maintenance of Subgrade:

1. Maintain ditches and drains along subgrade at all times as required to effectively drain the subgrade. Do not disturb finished subgrade by traffic or other operations. Protect and maintain subgrade in a satisfactory condition until ballast, subballast, base, or pavement is placed. Do not store or stockpile materials on the finished subgrade.

2. Obtain Engineer's inspection and approval of subgrade prior to laying base, subballast, ballast, or pavement. Place no base, subballast, ballast, surfacing, or pavement on a muddy, spongy, or frozen subgrade.

3.07 COMPACTION

A. Do not compact fill or backfill until it has attained the required moisture content. Add an accurately determined and carefully measured amount of water to the materials or surfaces which are too dry. Dry material containing an excess of moisture by manipulation, aeration, drainage, or other means before being compacted. Refer to Field Quality Control field moisture and related testing.

B. When subgrade has been prepared and has reached required grade, proof-roll surfaces to determine if soft spots exist in the material using a 50-ton pneumatic-tired roller or similar approved equipment. If wet or spongy areas are revealed, notify the Engineer so that corrective measures may be determined. Remove soft spots and refill until they meet the required compaction. Proof-roll areas which support the track structure, paving, utility structures, buildings, or other structures in the presence of the Engineer and obtain the Engineer's approval before further earthwork operations are performed.

C. In addition to proof-rolling, perform field density tests as specified under Field Quality Control herein.

D. Use power-operated or power-driven hand operated equipment wherever possible to compact to requirements specified herein. Do not operate mobile equipment closer to foundation than a horizontal distance equal to the height of backfill above bottom of wall. Accomplish compaction using sheep foot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibrator compactors, or other approved equipment well suited to the type of material being compacted.

E. If the degree of compaction is unsatisfactory, make necessary adjustments until specifications are met. Remove material placed over layers not satisfactorily compacted and re-compact unsatisfactory areas.

F. Unless otherwise noted, relative compaction of fill materials composing each layer of fill shall not be less than 95 percent as determined by ASTM D1556.

G. These compaction requirements do not apply to material placed in stockpiles or waste areas.

3.08 EXCESS MATERIAL

A. Dispose of material authorized to be wasted outside the work site in accordance with GC7.15, Disposal of Material Outside the Work Site, or at waste areas designated on the Contract Drawings, if applicable. Do not dispose of any excavated material in such a manner as to obstruct the flow of any stream, impact wetlands, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

B. The following requirements apply to waste sites designated in the Contract Documents for the Contractor's use:

1. The limits of the storage location will be designated by the Engineer. Keep stockpiles clear of tracks and other facilities, and preventing erosion. Create stockpiles in a manner that does not disturb or damage other work.

2. Construct discrete stockpiles that measure no more than 1000 cubic yards and in a shape that is easily measured by the Engineer or surveyor.

3. Avoid mixing of dissimilar materials. Construct each stockpile of similar material, such as non-impacted overburden soil, obviously compacted soil, or debris. Segregate dissimilar debris materials to facilitate salvage or recycling.

4. Move soil impacted by contaminants around the work site only with the approval of the Engineer.

5. Protect stockpiled soil in accordance with Section 01560, Temporary Controls. Cover stockpiles with plastic sheeting secured against removal by wind or rain. On a daily basis, inspect plastic sheeting covering stockpiles and make necessary repairs.

6. Inform the Engineer each day of the number and locations of stockpiles created that day.

7. When the Engineer has completed sampling from a stockpile, the Engineer will place an identification sign in the stockpile. From that date forward, add no soil to nor remove soil from the stockpile without the approval of the Engineer.

3.09 FIELD QUALITY CONTROL

A. Testing shall be performed by an approved Inspection and Testing Agency retained by the Contractor.

B. Unless otherwise indicated, perform field in-place density testing in accordance with ASTM D1556. Perform field density tests in accordance with ASTM D1556 (Sand-Cone Method). Periodically verify density tests by the nuclear probe method in accordance with ASTM D2922 with density tests from the Sand-Cone method. Minimum number of field density tests shall be as follows:

1. One field density test shall be taken for every 300 linear feet of track for each lift of soil placed and at each grade crossing.

2. One field density test shall be performed for each 1,000 square feet of embankment for each layer of compacted fill.

C. Determine the relative compaction of fill materials composing each layer of fill in accordance with ASTM D1556. Perform testing at same frequency as specified for field in-place density testing.

D. Maximum Dry Density and Optimum Moisture Content: The maximum dry density and optimum moisture content of non-granular soils (greater than 12 percent by weight passing through a No. 200 sieve) shall be determined by one of the methods described in ASTM D1557.

E. Moisture Control: Perform field moisture tests in accordance with ASTM D3017 (Nuclear Probe Method). At the time of compacting, backfill material and the surface on which it is to be placed shall be within plus or minus two (2) percent optimum moisture content and meet specified compaction requirements.

END OF SECTION

SECTION 02310
AGGREGATE BASE COURSES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for aggregate base courses.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

2. D1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

3. D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

B. State of California, Department of Transportation Standard Specifications (Caltrans):

1. Section 6 Control of Materials

2. Section 26 Aggregate Bases

1.03 DEFINITIONS

A. Aggregate Base: Imported material for use in base courses for trackwork, roadway pavement, grade crossings, permanent platforms, sub-ballast, and other locations indicated on the Contract Drawings.

B. Degree of Compaction: Degree of compaction required is expressed as a percentage of the maximum dry density obtained by the test procedure presented in ASTM D698. The compaction required will be abbreviated hereinafter as a percentage of laboratory maximum density.

1.04 SUBMITTALS

A. Submit the proposed aggregate base course gradation distribution prior to proceeding with paving.

1.05 DELIVERABLES

A. Submit copies of waybills and delivery tickets during the progress of the work. Before the final payment is made, submit certified waybills and certified delivery tickets for all aggregates actually used.

B. Submit test reports for field density tests and source quality control tests.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Before stockpiling of material, clear and slope to drain stockpile sites.

B. Stockpile materials obtained from different sources separately.

1.07 QUALITY ASSURANCE AND QUALITY CONTROL

A. Perform sampling and tests of the aggregate base material in accordance with the Test Methods specified in Caltrans Standard Specifications Section 6-2, Quality Assurance, to determine compliance with Gradation, R-value, Sand Equivalent, and Durability Index.

B. Test the quality characteristics of aggregate base material at the frequencies specified in Caltrans Standard Specifications Section 26.

C. Aggregate samples must not be treated with lime, cement, or chemicals before testing for durability index. Aggregate from untreated reclaimed processed AC, PCC, LCB, or CTB is not considered treated.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Aggregate Base (except as used as sub-ballast): Aggregate shall conform to Caltrans Standard Specifications, Section 26, Class 2 Aggregate Base, 3/4 inch maximum gradation.

B. Aggregate Base used as sub-ballast: Aggregate shall conform to Caltrans Standard Specifications, Section 26, Class 2 Aggregate Base, 3/4 inch maximum gradation. In addition, aggregate for sub-ballast shall consist entirely of crushed stone and have at least two fractured faces. No reclaimed asphalt or concrete shall be included in this material.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Request Engineer's inspection of and obtain Engineer's written acceptance of the prepared subgrade or subbase before proceeding with the placement of aggregate base course.

B. Confirm that immediately prior to spreading base course, the subgrade or subbase to receive aggregate base course conforms to the compaction and elevation tolerances indicated for the material involved and is free of standing water and loose or extraneous material. Subgrade shall conform to the requirements of Section 02300, Earthwork.

1. Confirm that underlying material has been excavated to sufficient depth to accept the required base course thickness such that the finished base

course with the subsequent surface course will meet the final grade.

3.02 PREPARATION

A. Prior to installation of base courses, area shall conform to the lines, grades, cross section, and dimensions indicated.

B. Correct areas of underlying course which exhibit ruts or soft and yielding spots and areas having inadequate compaction as specified in Section 02300, Earthwork. Remove and replace soft and yielding spots and areas having inadequate compact with suitable material. Underlying course may be mechanically stabilized with aggregate prior to placement of the base course. Stabilization may be accomplished by mixing base course material into the underlying course and compacting by approved methods. Properly compacted material will be considered as part of the underlying course and shall meet all requirements for the underlying course in accordance with Section 02300, Earthwork.

C. Prevent disturbance of finished underlying course by traffic or other operations and maintain it in a satisfactory condition until base course is placed.

D. Before placing base course, clean underlying course of foreign substances. When the base is constructed in more than one layer, the previously constructed layer shall be cleaned of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable.

3.03 INSTALLATION

A. Prepare, place, and compact base course in accordance with Caltrans Standard Specifications Section 26.

B. Minimum Uniform Compacted Thickness: Minimum compacted thickness shall be 6 inches.

C. The finish of finished aggregate base course at any point shall not vary more than 1/2 inch above or below the indicated grade.

3.04 FIELD QUALITY CONTROL

A. Perform field in-place density testing in accordance with ASTM D1556 or ASTM D6938.

B. Frequency of Field In-Place Density Tests: Perform no less than one test for each 2,000 square feet of base course material, per layer or lift.

END OF SECTION

SECTION 02360

MSE RETAINING WALL

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section specifies requirements for Mechanically Stabilized Embankment (MSE) Retaining Walls. This work shall consist of designing, furnishing materials and placement of mechanically stabilized embankment retaining walls, subsequently referred to as MSE walls. The MSE wall system shall consist of non-structural leveling pads, reinforced concrete facing panels and metal reinforcement elements mechanically connected to each facing panel. The Contract Drawings show MSE walls with cellular concrete fill. The Contractor may propose to use soil backfill as an alternative by submitting a cost reduction proposal to the Engineer for consideration in accordance with GC 4.2.5, Cost Reduction Proposals.

1.02 REFERENCE STANDARDS

A. PCJPB Standards for Design and Maintenance of Structures

B. AREMA Chapter 8, Part 7 Mechanically Stabilized Embankment

C. AASHTO Standard Specifications for Highway Bridges, 17th Edition

D. ASTM International (ASTM):

1. A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

2. A572 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

3. A1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

4. A1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

1.03 QUALITY CONTROL

A. Logs - The Contractor shall provide the Engineer with installation logs within 24 hours of the end of each work shift.

1.04 SUBMITTALS

A. Design Calculations: The Contractor shall submit complete design computations sealed and signed by a registered Civil Engineer in the State of California.

B. Submit manufacturer's product data including color and style, license requirements, and installation instructions and membrane samples for approval.

C. Submit a plan for installation of the proposed MSE wall system.

D. Submit shop drawings conforming to Section 01300 Submittals and Deliverables. Drawings shall include all details, dimensions, quantities and cross-sections necessary to construct the wall and shall include:

1. An elevation drawing or drawings for each wall.

2. An elevation or suitable table which shall include the elevation at the top of the wall at all horizontal and vertical break points and at least every 50 feet along the face of the wall, all steps in the leveling pads, the designation as to type of panel, the length of soil reinforcing elements, the distance along the face of the wall to where changes in the length of reinforcing occur, and an indication of the final ground line and maximum calculated bearing pressure.

3. A typical cross-section(s) showing the elevation relationship between current and interim (if applicable) ground conditions and proposed grades.

4. General notes pertaining to design criteria and wall construction.

5. A summary of quantities.

6. All panel details shall show all dimensions necessary to construct the element, all reinforcing steel in the element, and the location of soil reinforcing connection devices embedded in the panel.

7. Details of architectural treatment. Provide mockup samples of the MSE face panels with architectural treatments for review and approval prior to commencing fabrication. Samples shall be provided on-site for review and shall be large enough to demonstrate the final architectural finish, but no smaller than by 30 inches x 30 inches.

8. Details for diverting soil reinforcement around obstructions or to accommodate special features, such as coping.

9. Details for connections between the concrete MSE face panel and the steel reinforcing elements. Details for connections between the concrete curb and the steel seismic tie.

E. Materials, installation procedures and details for routing of counterpoise wire from stray current test well to ground rods. MSE wall shall be designed to mitigate the effects of stray current corrosion of steel reinforcing, prestressing elements, and other steel components. This will require that electrical continuity be provided between all steel elements within the MSE wall embankment with provisions to connect the components to a central location. Comply with CPUC GO 95, AREMA Chapter 33, IEEE, NESC, and NEC provisions for stray current.

1.05 QUALITY ASSURANCE

A. Coupler test samples must comply with the minimum tensile specifications for plain wire in ASTM A1064A/1064M.

B. Total wire slip must be at most 3/16 inch when tested as specified for tension testing of round wire test samples under ASTM A370.

C. If any test samples fail, revise the connection and retest. Do not start face panel installation until tension and slip test results are accepted.

D. Perform tension and slip tests on the proposed button-head wire soil reinforcement and coupler connection. Test 6 connection test samples. Test samples must consist of two 24-inches long button-head wires connected by a swaged coupler. Testing must be performed by an authorized laboratory.

E. Perform tension and slip testing on production button-head wire and coupler connections during wall construction. Test 4 connection test samples for each lot of 500 mat wire connections installed. If 2 or more test samples fail, the entire represented lot is rejected. If 1 test sample fails to comply with specified criteria, test an additional 4 test samples. If any of these additional samples fail, the entire represented lot is rejected.

PART 2 - PRODUCTS

2.01 MATERIALS

A. The Contractor shall provide the materials covered by this section, including concrete facing panels, reinforcing elements, attachment devices, fasteners, joint materials, coping, underdrains, soil backfill alternative, cellular concrete and necessary incidentals. The Contractor shall furnish the Engineer a Certificate of Compliance certifying that the applicable materials comply with this section. Materials not conforming to this section shall not be used without the written consent of the Engineer.

1. Earthwork - Excavation and cellular concrete shall conform to the details shown on the plans, the provisions in Section 02300 Earthwork, Section 03310 Cellular Concrete and these specifications.

    a. Water used for earthwork or dust control within 500 feet of earth retaining structures with metallic reinforcement shall be potable, clear and free of injurious amounts of oil, acid, alkali, salts, organic matter, and any other substances that may be deleterious to concrete or steel per Section 03300 Cast-In-Place Concrete.

    b. For soil backfill embankment, backfill material must comply with PCJPB Standards for Design and Maintenance of Structures, Article 9.5.4 (b) MSE Structural Backfill.

2. Galvanizing – Soil reinforcement, connecting elements, and other steel components shall be galvanized in conformance with the provisions in Section 05100 Metal Fabrications.

3. Subdrainage System - Drainage system shall conform to the provisions in Section 02620.

4. Reinforcing Strips - Reinforcing strips shall conform to the details shown on the contract plans, the approved working drawings, the preapproved proprietary system details, and these specifications.

    a. The MSE wall shall be provided with inspection elements for removal and verification of the rate of corrosion of the steel reinforcing elements occurring over the life of the wall. Inspection elements shall be clearly and permanently marked on the wall in the MSE face panels with the following intervals for inspection: 5, 10, 25, 50, 75, and 100 year time periods with a separate inspection element for each year. The detail, frequency and location of inspection elements shall be submitted for review and approval.

    b. Steel wire must comply with the specifications for plain wire reinforcement in ASTM A1064/A1064M. Welded wire reinforcement must comply with the specifications for plain wire welded wire reinforcement in ASTM A1064/1064M. Steel wire reinforcement hooks and bends must comply with the Building Code Requirements for Structural Concrete published by ACI. For button-headed wires:

        1) Buttons must be cold formed symmetrically about the axes of the wires

        2) Buttons must develop the minimum guaranteed ultimate tensile strength of the wire

        3) Do not use a cold-forming process that causes indentations in the wire

        4) Button heads must not contain wide open splits, more than 2 splits per head, or splits nonparallel to the axis of the wire

    c. No installation of face panels shall be allowed until the Contractor has successfully completed tension and slip testing for proposed reinforcement strips and coupler connectors.

    d. Couplers at wire reinforcement connections must be seamless steel sleeves applied over the button-head wires. Couplers must develop the wire minimum tensile strength with a total slip of at most 3/16 inch. Splice welded wire reinforcement along its length with mechanical couplers shall develop the minimum tensile strength of the wire. The mechanical coupler shall be approved by the Engineer.

e. Ribbed reinforcing strips shall be hot rolled from bars conforming to ASTM A572. Tie strips shall be shop fabricated of hot rolled steel conforming to ASTM A1011.

PART 3 - EXECUTION

3.01 PREPARATION

A. Employ Installer to examine conditions of substrates and other conditions under which this work is to be performed and notify the contractor, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions are corrected.

B. Design Requirements:

1. MSE Wall shall be designed in conformance with AREMA and AASHTO Standard Specifications for Highway Bridges.

2. The design pertaining to the external stability of MSE wall is the responsibility of the Owner, which includes slope stability, bearing capacity, and total and differential settlements. The Contractor is responsible for the design of all other aspects of MSE wall, which includes but not limited to the stability of the wall with regard to pull-out of reinforcement, strength of the reinforcement-to-facing connections, and internal stability of the embankments. The design life of the MSE wall system shall be 100 years. When designing soil reinforcement, metal loss over time shall be considered. Metal loss rates shall be in accordance PCJPB Standards for Design and Maintenance of Structures, Article 9.5.4 (a).

3. The minimum factor of safety for pullout resistance of the reinforcing strip shall be 1.75, per AREMA section 7.2.1b.

4. MSE walls shall be designed for live load based on Cooper's E-80 load. Lateral pressure resulting train load shall be computed using the Boussinesq equation. For multiple track embankments, train loads from all tracks affecting the design of an MSE wall shall be considered. For two tracks, include full surcharge from both tracks. For three tracks, include full surcharge from the two closest tracks and 50% surcharge from the third track. For four tracks, include full surcharge from the two closest tracks, 50% surcharge from the third track, and 25% surcharge from the fourth track.

5. Geotechnical design parameters for MSE soil backfill and cellular concrete fill shall be determined in accordance with the project Geotechnical Investigation Report.

C. Tolerances:

1. The MSE wall shall be constructed to the lines, grades, details and limiting parameters shown on the plans, and shall conform to these specifications. The bottom of wall elevations or face panels shall be at or below the elevations shown on the plans. The height and length to be

used for any system shall be the minimums for that system that will effectively retain the cellular concrete material behind the structure for the loading conditions and the contours, profile, or slope lines shown on the plans.

2. The surface of the wall face shall be tested with a 10' (3 m) straightedge laid along the surface in all directions. Except as necessary for horizontal alignment of the wall, convex deviation of the wall face from the straightedge (belly wall) shall not be allowed, and concave deviation from the straightedge shall be less than 1/2" (12 mm). The maximum allowable offset in any panel joint shall not exceed 3/4 inch.

3. Panels shall be manufactured within the following tolerances:

   a. Lateral position of reinforcing strip attachment devices shall be within one inch. Embedment measure from the back face of the panel shall be within +1/4 to -1/2 inch. Bearing surfaces of multiple attachment points for a single soil reinforcing element shall align within 1/16 inch.

   b. Panel Dimension: All panel dimensions shall be within ¼ inch. All hardware embedded in the panel with the exception of attachment devices shall be within ¼ inch.

   c. Panel Squareness: Squareness, as determined by the difference between the two diagonals, shall not exceed ½ inch.

   d. Panel Surface Finish: Surface defects on smooth-formed surfaces, measured on a length of 5 feet, shall not exceed ¼ inch. Surface defects on textured-finished surfaces measured on a length of 5 feet, shall not exceed 5/16 inch.

   e. Leveling pad: The leveling pad shall be cast to the design elevations on the plans and to the tolerances of +1/8 to -1/4 inch.

D. Placement:

1. The top level of reinforcement shall be placed parallel to the top of the concrete panel at a distance below the top of the wall as shown on the plans. The top level of reinforcement shall also be (1) placed a minimum of 3 inches below the bottom of the barrier slab lip or the bottom of the concrete gutter behind coping and (2) placed a minimum of 5 inches below the top edge of the concrete panel.

2. Cellular concrete material shall be placed simultaneously with the erection of the facing panels. Placement shall be accomplished without distortion of the reinforcement or displacement of facing panels.

3. Reinforcement shall be tensioned in the direction perpendicular to the wall face with enough force to remove any slack in the connection or in the reinforcement itself. Reinforcement shall be secured in place to

prevent movement during placement of additional reinforcement and cellular concrete.

4. Reinforcing strips shall be covered with cellular concrete during the same work shift that it is placed.

5. Construction equipment shall not be operated directly on the reinforcement.

6. At each level of the reinforcement the cellular concrete shall be constructed to a plane 2 inches above the elevation of the reinforcement connection.

E. Concrete:

1. Concrete for the leveling pads shall be placed at least 24 hours prior to erecting face panels.

2. Exposed surfaces of precast and cast-in-place concrete members shall be painted concrete conforming to the provisions in Section 09900 Paints and Coatings and specific color described in the architectural drawings and receive a surface pattern and finish conforming to the provisions in Section 03100, Concrete Forming, and Section 03170, Concrete Finishing.

3. After placement of an inspection element and placement of cellular concrete to a level at least 2 feet above the inspection element, the void in the face panel shall be dry packed with mortar as shown on the plans. Dry pack shall have proportion of cementitious material to sand such that a 28-day mortar compressive strength of 1000 psi to 1500 psi is achieved.

F. Proprietary Earth Retaining Systems:

1. For proprietary earth retaining systems that are pre-approved for use on this project, see the Caltrans Authorized Systems List at: https://dot.ca.gov/programs/engineering-services/authorized-materials-lists.

2. If the Contractor elects to construct one of the acceptable proprietary alternative earth retaining systems, the structure shall be constructed to the lines and grades shown on the plans. Vertical and horizontal alignment shall be checked at every course throughout the erection process. The construction shall conform to the details shown on the approved working drawings, approved proprietary system details, and these specifications.

3. The Contractor shall supply a Certificate of Compliance conforming to the provisions in Section 01300 stating the supplied material meets these specifications and the approved working drawings.

4. A qualified representative of the proprietary earth retaining system manufacturer shall be present during erection and placement of cellular

concrete of the first 10 feet of height of the entire length of the wall and shall be available during any remaining installations. The manufacturer's representative shall not be an employee of the Contractor.

G. Counterpoise / Grounding:

1. Contractor is to provide installation procedures, materials, and details for routing of the counterpoise from the stray current test wells at each end of the station platform to ground rods installed in soil at the base of the MSE wall. The counterpoise wire passing vertically through the cellular concrete to the base of the MSE wall shall be protected in conduit. Conduit shall be minimum 1 inch PVC schedule 40. Routing and installation details are to be coordinated with the design of the MSE wall system.

END OF SECTION

SECTION 02400

UTILITY JACKING AND BORING

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes specifications for jack and bore installation of pipe, casing, or conduit.

1.02 SUBMITTALS

A. Obtain Engineer's approval of the following submittals:

1. Submit working drawings describing the proposed jack and bore. Include arrangement of equipment; location and size of jacking and receiving pits including their relative location to tracks; method of dewatering; method of monitoring for possible settlement; method to prevent loss of the excavation face; method of removing spoils material; and carrier pipe size, method of fusing pipe segments, and carrier pipe end seals. Include sufficient information to show compliance with the Contract Documents.

2. Support of excavation for pits: Submit the proposed methods of construction, design, and details for pit excavation shoring systems. Refer to Section 02200, Support of Excavation, for related submittals for support of pit excavation.

3. Emergency remediation plan:

   a. Identify methods to cut and remove rock, concrete, or timber encountered at the boring face and methods to temporarily bulkhead the face.

   b. Identify remedial measures for limiting damage to existing facilities, impact to tracks, and railroad operations due to ground settlement.

   c. The Contractor must have the resources to execute this plan immediately available.

4. Submit product data including catalog cuts and other descriptive data.

5. Experience: Submit list of references substantiating jack and bore installer's experience.

1.03 DELIVERABLES

A. Submit copies of test reports for material properties and compaction as required in this Section.

B. Incorporate the following data in Record (As-Built) Drawings: As-built survey drawing of completed jack and bore installation including horizontal and profile drawings.

C. Support of excavation for pits: Refer to Section 02200, Support of Excavation, for related deliverables for support of pit excavation.

1.04 QUALITY ASSURANCE

A. Jack and bore installer shall have documented experience in successfully completing similar installations within the past five years.

B. Support of excavation for pits: Refer to Section 02200, Support of Excavation, for related quality assurance requirements for support of pit excavation.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Materials shall be as indicated in the Contract Documents and the approved submittals.

B. Pipes used shall meet requirements specified in AREMA Chapter 1, Part 5 Utilities.

C. Cement Slurry, As Applicable: As specified in approved submittals.

PART 3 - EXECUTION

3.01 GENERAL

A. Verify the actual locations (horizontal and vertical) of all utilities prior to beginning work.

B. If utilities are to remain in place, provide protection from damage during construction operations.

C. Excavation and Support of Excavation for jacking and receiving pits shall be in accordance with Section 02300, Earthwork, and Section 02200, Support of Excavation.

3.02 HANDLING OF MATERIAL

A. Handle pipes, conduits, casing, and ancillary items in such a manner as not to damage the material. Damage to the material, including linings or coatings, shall be repaired to the satisfaction of the Engineer or replaced.

B. Do not drop or drag pipes, conduits. Handle with rolling slings on skids or with cranes.

C. Do not use bent or otherwise damaged material shall not be used.

3.03 JACK AND BORE

A. Perform jack and bore operations in accordance with approved submittals and the following requirements:

1. The front of the pipe shall be provided with mechanical arrangements or devices that prevent the auger from leading the casing so that no unsupported excavation is ahead of the casing.

2. The use of water or slurry under pressure (jetting) or puddling shall not be permitted to facilitate boring, pushing, or jacking operations. Water or slurry used to lubricate the cutter and pipe is acceptable.

3. Unless otherwise indicated in the Contract Documents, or accepted by the Engineer in the approved submittals, pipe, conduit, and casing installation under tracks shall be progressed on a continuous basis without stoppage, except for adding sections, until the leading edge has reached the receiving pit.

B. Stop operations for the passage of trains. Employ methods to prevent loss of the excavation face in accordance with approved submittals.

C. Stop operations if ground settlement is detected and employ the emergency remediation plan in accordance with the approved submittals. Repair any damages to the tracks, including track displacement resulting from the construction's operations. The corrective action shall be approved by the Engineer.

D. With the use of spacers, place the carrier pipe in the casing pipe such that there is equal space between the casing pipe and carrier pipe, and fill the space with cement slurry, unless otherwise indicated in the Contract Documents.

3.04 FIELD QUALITY CONTROL

A. Refer to Section 01400, Quality Control and Assurance. Testing shall be performed by an Engineer-approved Inspection and Testing Agency retained by the Contractor.

END OF SECTION

SECTION 02500

UNDERGROUND DUCTWORK AND STRUCTURES

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes requirements for conduits, precast concrete structures, cast-in-place concrete ductbank and structures, including frames, covers, gratings, steps and sumps, and cover identification.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. A48 Standard Specification for Gray Iron Castings
2. A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
3. A536 Standard Specification for Ductile Iron Castings
4. B26 Standard Specification for Aluminum-Alloy Sand Castings
5. C33 Standard Specification for Concrete Aggregates
6. F512 Standard Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation

B. California Code of Regulations:

1. Title 24, Part 3 California Electrical Code

C. State of California Public Utilities Commission (CPUC) General Orders (GO):

1. 128 Rules for Construction of Underground Electric Supply and Communications Systems

1.03 SUBMITTALS

A. Submit shop drawings for fabrication and installation of precast concrete structures, cast-in-place concrete structures, and concrete-encased underground ductwork, including the following:

1. Cast-in-place and precast detailed steel reinforcement drawings; and precast manufacturer's concrete mix designs for structures and colored concrete as indicated.

B. Submit product data including the following:

1. Complete materials list of items proposed to be furnished and installed under this Section.

2. Manufacturers' specifications and other data required to demonstrate compliance with these Specifications.

3. Catalog cuts for the following products:

   a. Conduits.

   b. Underground duct system, duct spacers, including manholes, pull boxes, handholes, cable junction boxes, and termination boxes.

   c. Manhole, pull box, and handhole covers and frames.

   d. Related miscellaneous hardware and metal items for cable trenches and wireways.

   e. Trench and wireway covers including composition of FRP materials, divider partition panels, method of joining sections, expansion joint mounting, and support details.

C. Submit concrete mix designs for cast-in-place concrete under Section 03300, Cast-in-Place Concrete. Submit concrete sample showing proposed concrete color for approval.

D. Qualifications: Submit manufacturers' qualifications.

E. Submit certificates of compliance for all specified products.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the State Electrical Code, and CPUC General Order No. 128. In case of conflict between the State Electrical Code and CPUC G.O. 128, the provisions of CPUC G.O. No. 128 shall govern.

B. Qualification of Manufacturers:

1. Manufacturers of the products specified for work under this Section shall be in the business of manufacturing similar products and shall be able to provide a history of successful production of the specified products.

2. Submit a list of five major projects, where similar products have been supplied, which have been in satisfactory use or operation for the past five years.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Conduit and Pull Cord: Provide PVC conduit, minimum Schedule 40, and all necessary fittings, in sizes as indicated, and pull cord as specified in Section 16130, Conduit and Fittings. Provide flared bell ends on conduits and ducts entering manholes, handholes, and pull boxes.

B. Precast Concrete: Provide precast concrete structures in accordance with requirements as indicated in this Section.

1. Precast concrete electrical boxes, pull boxes, ground rod boxes, manholes, handholes, and vaults shall be provided as indicated. Concrete reinforcement shall be that which is regularly provided in standard products of the manufacturer. Standard manufactured structures that meet project requirements will be acceptable. Provide concrete inserts for mounting cable support brackets as indicated.

2. Provide covers with two lifting eyes and two hold-down bolts. Each box shall have a suitable opening for a ground rod, and a drainage opening.

C. Sand: Sand for filler material, where indicated, and for bedding of conduit shall be bedding material specified in Section 02300, Earthwork.

D. Aggregate Base: As specified in Section 02310, Aggregate Base Courses.

E. Cast-In-Place Concrete for Ductbank Encasements, Manholes, Pull Boxes, and Vaults:

1. Concrete shall be Class 3000 in accordance with Section 03300, Cast-in-Place Concrete, for ductbank encasements, manholes, pull boxes, and vaults. Concrete for ductbank encasements shall be colored with a red mineral coloring pigment as specified in Section 03160, Colored Concrete. Color: Red.

2. Formwork and concrete placement shall conform with applicable requirements of Section 03100, Concrete Forming, and Section 03300, Cast-in-Place Concrete.

3. Reinforcing steel, as indicated, shall conform with applicable requirements of Section 03200, Concrete Reinforcing.

2.02 FRAMES, COVERS, STEPS, AND SUMPS

A. Ferrous Castings:

1. Metal used in manufacture of castings shall conform to ASTM A48, Class 35B for Gray Iron, or ASTM A536, Grade 65-45-12 for Ductile Iron.

2. Castings shall be of uniform quality, free from blowholes, shrinkage, distortion or other defects. Castings shall be smooth and cleaned by shotblasting.

3. Minimum tensile strength shall be 35,000 psi.

4. Castings shall be manufactured true to pattern; component parts shall fit together in a satisfactory manner. Round frames and covers shall have continuously machined bearing surfaces to prevent rocking and rattling.

5. Where castings will be subjected to loads of H20 or greater, provide ductile iron castings.

B. Aluminum Castings: Where required to reduce weights of larger covers for ease of handling, such covers may be manufactured of aluminum castings conforming to ASTM B26/B26M, Alloy No. 713.0. Minimum tensile strength shall be 32,000 psi.

C. Manhole Covers: Provide cast, manufactured manhole covers and frames with heavy-duty solid cover (lid) or vented cover (lid). Covers shall be embossed or engraved with nonslip diamond or square cross-hatched pattern.

1. Provide metal covers with embossed or engraved word identification for the enclosed or underground utility.

D. Precast Covers: Precast covers shall have the utility identification stamped into the cover.

E. Cast Iron Manhole Steps: Provide cast, manufactured manhole steps with cross-hatched treads and with anchor configuration appropriate for cast-in-place concrete or precast concrete. Provide steps for installation 12 inches on center in vertical alignment.

F. Ladders: Provide standard-manufactured or custom-fabricated steel ladders as required to meet the conditions indicated. Steel ladders shall be hot-dip galvanized after fabrication.

G. Galvanizing: All ferrous metal items shall be galvanized after fabrication by the hot-dip process in accordance with ASTM A123. Weight of the zinc coating shall conform with the requirements specified under "Weight of Coating" in ASTM A123.

2.03 REINFORCED PLASTIC MORTAR SPACERS (RPM)

A. Duct spacers shall be made from high density polyethylene (not less than 0.96 specific gravity), as manufactured by Formex Manufacturing, Inc., Underground Devices Inc. make, or equal.

B. Duct Spacers:

1. Duct spacers shall be double wall construction. Spacers shall consist of interlocking modules, i.e. bases, intermediates, and caps, designed to provide independent support for each duct.

2. When spacer modules are locked together, openings shall provide approximately 1/16 inch clearance over the outside diameter of the duct. The interior surface of the duct spacer opening shall be convex to prevent kinking of the duct.

3. Configure spacer module openings to ensure the horizontal and vertical separations for each duct as indicated on the Contract Drawings.

PART 3 – EXECUTION

3.01 VERIFICATION

A. Before beginning construction or installation of a section of underground conduit or ductwork, verify that the site is in suitable condition for installing such conduit or ductwork as indicated.

3.02 EXAMINATION AND EXCAVATION, TRENCHING AND BACKFILLING

A. Perform excavation, bedding, and backfilling for underground conduits and structures in accordance with Section 02300, Earthwork, or as indicated.

3.03 INSTALLATION

A. Underground Duct System: Locate duct system, conduit, pull boxes, and manholes as indicated on the Contract Drawings. Comply with applicable requirements of CPUC GO 128.

B. Ductbank Reinforcing Detail:

1. Provide longitudinal reinforcing steel with a minimum total cross sectional area of 0.0018 times the gross area of the ductbank. Maximum spacing of reinforcement bars shall be 18 inches; minimum of one bar in each corner of ductbank.

2. Provide steel tie bars in the transverse direction enclosing the longitudinal bars; minimum size of No. 3 bars; minimum spacing of 12 inches. Minimum clear concrete cover over reinforcement steel shall be 3 inches where concrete is cast directly against earth, and 1-1/2 inches where concrete is cast directly against formwork.

3. Where ductbank enters rigid underground structures, provide reinforcing steel to tie the ductbank to the structure. Provide details indicating method employed to prevent differential settlement from damaging ductbanks.

C. Ducts:

1. Inspect ducts and couplings to ensure that only clean and undamaged pieces are incorporated in the work.

2. Ductbanks or conduits shall have a minimum slope of 3 inches to each 100 feet away from buildings and towards manholes, pull boxes, and handholes, and shall run in straight lines between indicated changes in direction.

3. Individual conduits that are grouped together to form a ductbank shall conform to the standards and requirements specified herein.

4. Accomplish horizontal or vertical changes in direction exceeding ten degrees by long sweep bends having a minimum radius of curvature of 25 feet, except that manufactured bends may be used at ends of short

runs of 100 feet or less, and then only at or within 5 feet of the end of the run. Sweep bends may be made up of curved or straight sections, or combinations thereof. Manufactured bends shall have a minimum radius of 36 inches for ducts of 3 inches in diameter and larger.

5. Terminate conduits in end-bells where duct lines enter vaults.

6. Place spacers or space separators not more than 6 feet apart.

7. Install ducts, joints, and space separators according to manufacturer's printed instructions and recommendations.

8. During non-work hours and at locations where installation of conduits and ducts is temporarily suspended or terminated, close ends of ducts with caps or plugs fitted to prevent entry of water or debris. Use caps or plugs designed for that purpose by the conduit manufacturer.

9. During construction, protect partially completed duct lines from the entrance of debris by means of suitable caps or plugs. As each section of a duct line is completed between manholes, handholes, or pull boxes, draw a mandrel through each conduit as specified in Section 16130, Conduits and Fittings, after which draw a brush with stiff bristles through until the conduit is clear of particles of earth, sand, or gravel. Immediately install conduit caps or plugs.

10. Construct the concrete-encased ductbank with 3 inch minimum cover on all sides.

11. Install 1/8 inch or larger diameter pulling cord in ducts including inner ducts. Fasten each cord to pull iron anchorage in pull box, manhole, or vault with 2 feet minimum slack.

12. Place innerduct in communications conduits avoiding excessive tension and deformation of the innerduct. Replace damaged or necked down innerduct. Conform to the manufacturer's installation instructions.

13. Provide metallic numbering tags indicating the conduit number on both ends of all conduit runs.

D. Concrete Structures, General: Install pull box tops flush with sidewalks or curbs. Install 1-1/2 inches above surrounding grades when remote from curbed roadways or sidewalks.

E. Precast Concrete Structures: Install precast electrical boxes, pull boxes, handholes, manholes, and vaults as indicated. Place boxes on 4 inches of compacted sand bedding. Place manholes on 6 inches of compacted aggregate base. Seal conduit, cable, ground rod entrances, and unused openings with cement mortar.

F. Cast-In-Place Concrete Structures:

1. Obtain Engineer’s approval of the location of each pull box, manhole, and vault before construction of such structure is started. Construct top,

walls, and bottom of reinforced concrete. Construct walls and bottom of monolithic concrete.

2. Place concrete for pull boxes, manholes, and vaults on well-compacted soil with a minimum of 6 inches of aggregate base. Seal all sumps.

3. Where duct lines enter pull boxes, manholes, and vaults, the sections of duct may be either cast in the concrete or may enter through a square or rectangular opening of suitable dimensions provided in the utility structure. Install cable-pulling iron anchorage in the wall opposite each ductbank entrance.

3.04 REINFORCED PLASTIC MORTAR SPACERS (RPM)

A. Use base pads to ensure specified dimensions between trench floor and bottom of first tier of ducts. Assemble and anchor ducts and duct spacers using reinforcing bars or trench jack and adjusting wedges in accordance with duct spacer manufacturer's written instructions. Ensure that duct spacing is maintained and that ducts do not float as a result of concrete pour.

B. For each 20 feet length of duct, provide a minimum of four spacer locations. Place duct spacers not more than six feet apart; transmit no vertical load to conduit.

C. For bore spacers where ductwork is installed in casings, refer to Section 16130, Conduits and Fittings.

3.05 FIELD QUALITY CONTROL

A. Notify the Engineer for inspection and sign-off of the following installations:

1. Completed underground installations: Obtain the Engineer's inspection and acceptance before installation of cable and equipment.

B. Perform corrective work required to obtain approval of underground construction and ductwork.

END OF SECTION

SECTION 02510

UTILITY GRADE ADJUSTMENTS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes specifications for adjusting existing utility structures to new finish grade including manholes, vaults, hand holes, drainage structures, and utility valve structures. Adjustment includes adding or replacing riser collars; and raising, lowering, or resetting existing frames, covers, grates, and lids.

1.02 SUBMITTALS

A. Shop Drawings: Submit shop drawings for approval showing modification for raising and lowering of each type of structure frame and cover impacted by the work of this Contract. Provide documentation that the modification can accommodate all loads resisted by the existing structure.

B. Product Data: Submit product data for approval for cast iron and pre-cast risers for adjustment of frames, covers, lids, and grating.

PART 2 – PRODUCTS

2.01 PRODUCTS

A. Provide cast iron or pre-cast concrete riser collars to suit existing structures, to support loads resisted by the existing structure, and in accordance with the requirements of the jurisdictional authority.

B. Miscellaneous Materials: As required and in accordance with the requirements of the jurisdictional authority and the approved shop drawings.

PART 3 – EXECUTION

3.01 ADJUSTMENT OF MANHOLE COVERS, GRATES, AND SIMILAR FACILITIES TO GRADE

A. Adjust existing facilities as shown on the Contract Drawings by raising or lowering to match the new grade line.

B. Construct or alter the structure to the required line and grade.

C. Use approved cast iron or pre-cast concrete riser collar.

D. Adjust frames and covers to new grade.

E. Perform asphalt pavement work after structures have been adjusted to new pavement grade.

F. Maximum adjustment of manhole covers, drainage grates, and valve covers shall be 12 inches plus or minus, unless noted otherwise.

END OF SECTION

SECTION 02620
SUBDRAINAGE SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for subdrainage systems (underdrains).

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. D1784 Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

2. D3212 Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

3. F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

4. F949 Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with Smooth Interior and Fittings

B. State of California, Department of Transportation Standard Specifications (Caltrans):

1. Section 19 Earthwork

2. Section 96 Geosynthetics

1.03 SUBMITTALS

A. Manufacturer's data sheet for pipe and fitting materials.

B. Certificate of compliance of the gradation requirements for the granular backfill material included in this Section.

C. Manufacturer’s data sheet and samples for filter fabric.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Pipe:

1. Polyvinyl Chloride (PVC), conforming to ASTM F949, 46 psi pipe stiffness, with double wall construction, PVC resin 12454 B per ASTM D1784.

2. Joints and Gaskets:

   a. Joints: Push-on type, designed for elastomeric gaskets, ASTM D3212.

   b. Gaskets: Rubber, ring type, ASTM F477.

3. Perforated pipe slot geometry shall provide a minimum inflow area of 0.5 SQ IN per LF. The perforations shall consist of two rows of 3/8" holes at 3" on centers parallel to the longitudinal axis of the pipe. The rows shall be approximately 1-1/2 inches apart but not spaced over more than 155 degrees of the circumference. The rows shall be arranged in a staggered pattern so that all perforations lie at the midpoint between perforations in adjacent rows. The spigot or tongue end of the pipe shall not be perforated for a length equal to the depth of the socket, and perforations shall continue at uniform spacing over the entire length of the pipe.

B. Backfill material for underdrains located within ballasted track areas shall be 3/4-inch round river rocks. Backfill for underdrains located outside ballasted track areas shall conform to the pervious backfill requirements of Caltrans Standard Specification 19-3.02C.

C. Filter Fabric: Filter fabric for underdrains in accordance with Caltrans Standard Specifications, Section 96-1.02B, Class A.

D. Cleanouts:

1. Provide cast iron bolt down type surface frames and covers adjusted to finish grade

2. Casting for Cleanouts: Cast Iron Frame and Lid, Neenah Foundry Company Floor Box Frame and Lid, or Engineer approved equal. Lid cast with the designation "Clean Out". Diameter of frame adequate to fit over outer diameter size of underdrain pipe.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Requirements:

1. Line excavated trench with filter fabric, as shown on the Contract Drawings.

2. Unless otherwise indicated, excavate trench and backfill in accordance with Section 02300, Earthwork.

3. Cap cleanout within track ballast at the surface opening.

B. Preparation of Trench Bottom:

1. Unless otherwise indicated, excavate trench bottom to an elevation 6 inches below bottom of pipe.

2. Fill trench bottom to the bottom of pipe grade with underdrain backfill material to ensure complete and continuous support for the barrel of the pipe.

3. Excavate bell holes to size necessary to accommodate joint.

C. Placement:

1. Lay pipes in the upstream direction to the lines and grades shown, with the bell point upgrade, and with perforations down.

2. Keep interior surfaces of pipes clean during placement. Block pipe ends with pipe caps or plugs to prevent filter material from entering the pipes.

3. Complete installation of geotextile filter fabric as shown on the Contract Drawings.

4. Prevent flooding the pipe trench before backfilling operations.

D. Unless otherwise indicated on the contract drawings, place granular backfill material for bedding uniformly along each side of the pipe in minimum widths of 6 inches, and a minimum depth of 12 inches above the top of pipe, after compaction. Space each layer to eliminate voids.

E. Make connections of solid wall outlet pipes to existing structures in accordance with Section 02630, Storm Drainage System.

3.02 FIELD QUALITY CONTROL

A. Notify and obtain Engineer's approval of pipes and accessories before lowering pipe into the trenches. Replace defective, damaged, or unsatisfactory pipes and accessories.

B. After pipe is laid and joined, notify and obtain Engineer's approval prior to backfilling. Take up and re-lay or replace, any pipe found to be out of alignment, unduly settled, or damaged.

END OF SECTION

SECTION 02630

STORM DRAINAGE SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for storm drainage systems including modifications and connections to existing storm drainage systems.

1.02 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1.	M36	Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains
2.	M190	Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches
3.	M218	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized), for Corrugated Steel Pipe
4.	M306	Standard Specification for Drainage, Sewer, Utility, and Related Castings

B. ASTM International (ASTM):

1.	A36	Standard Specification for Carbon Structural Steel
2.	A48	Standard Specification for Gray Iron Castings
3.	A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
4.	B26	Standard Specification for Aluminum-Alloy Sand Castings
5.	C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
6.	C150	Standard Specification for Portland Cement
7.	C270	Standard Specification for Mortar for Unit Masonry
8.	C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
9.	C478	Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
10.	C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete By Slant Shear

11. D1785 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

12. D2564 Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems

13. D2855 Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets

C. American Water Works Association (AWWA):

1. C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

2. C115/A21.15 Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges

D. State of California Department of Transportation Standard Plans (Caltrans)

E. State of California Department of Transportation Bridge Design Specifications (Caltrans)

F. Caltrain Engineering Standards for Excavation Support Systems

G. Greenbook Standard Specifications for Public Works Construction

H. American Society of Mechanical Engineers: ASME A112.3.1 Stainless Steel Drainage Systems for Sanitary DWV, Storm, & Vacuum Applications Above & Below Ground

1.03 SUBMITTALS

A. Submit manufacturer's data for pipe, structures, trench drains, and appurtenances.

B. Submit trench drain installation procedure including anchor method.

C. Submit shop drawings for fabrication and installation of precast and cast-in-place concrete drainage structures, including the following:

1. Cast-in-place and precast detailed steel reinforcement drawings; and precast manufacturer's concrete mix designs for structures.

2. Design calculations demonstrating that the required design parameters have been met.

D. Submit concrete mix designs for cast-in-place concrete under Section 03300, Cast in-Place Concrete.

1.04 DESIGN CRITERIA

A. Drainage structures shall be designed for all imposed loads including vertical live loading and lateral surcharge from railroad operations. Railroad operations loading shall be Cooper E-80. Lateral surcharge load shall conform to the requirements in the Caltrain Engineering Standards for Excavation Support Systems.

1.05 QUALITY ASSURANCE

A. Drainage structure designs including shop drawings and calculations shall be prepared, sealed, and signed by a Civil Engineer who is currently registered in the State of California.

PART 2 – PRODUCTS

2.01 PIPE

A. Reinforced Concrete Pipe:

1. Pipe: ASTM C76, bell and spigot type, Class V, Wall C, unless otherwise indicated

2. Rubber Gaskets: ASTM C443, oil resistant.

3. Cement for Concrete Pipe: ASTM C150, Type II

B. Polyvinyl Chloride (PVC) Pipe:

1. Pipe: ASTM D1785, Type I, Schedule 80

2. Provide fittings, such as adapters, couplings, tees and caps of same material as pipe

3. Cements: ASTM D2564

C. Ductile Iron Pipe:

1. Pipe: AWWA C151, Class 56. Cement lining is not a requirement for ductile iron being used for storm drainage.

2. Joints: AWWA C111, push-on type.

D. Corrugated Metal Pipe:

1. Pipe: AASHTO M36, Type II. Metal thickness shall be 12 gage for 36 inch diameter pipes or larger and 14 gage for smaller diameter pipes. Pitch shall be 2-2/3 inch by 1/2 inch. Pipe, coupling bands and other components shall be bituminous coated in accordance with AASHTO M190.

2. Corrugated metal coupling bands: AASHTO M36, Section 20. Coupling bands may either be one or two piece construction. Coupling bands

shall not be more than two thickness' (as listed in AASHTO M218, Table 4), lighter than the thickness of the pipe to be connected and in no case lighter than 0.064 inch. Bolts and nuts for coupling bands shall conform to ASTM A307.

E. Welded Steel Pipe: Caltrans Standard Specifications, Section 70-3, Welded Steel Pipe Drainage Facilities.

2.02 DRAINAGE STRUCTURES

A. Unless otherwise indicated, precast concrete drainage structures shall conform to ASTM C478, supplemented by the following:

1. Portland cement: ASTM C150, Type II A

2. Mastic gaskets at joints of precast concrete sections shall be Kent Seal No. 2 joint sealant or Engineer approved equal.

B. Fabricate precast concrete catch basins to the sizes indicated on Contract Drawings. Unless otherwise indicated by in Contract Drawings, catch basins shall have a minimum sump of 24 inches measured from the lowest inlet/outlet pipe invert indicated on the Contract Drawings to the bottom slab of the structure (interior face).

C. Drainage inlets (Catch Basins or Grate inlets): Caltrans Standard Plans, Drainage Inlet, Standard Type G1, unless otherwise noted. Drainage inlets may be cast-in-place concrete or equivalent precast inlets.

D. Fabricate frames and covers with provisions for adjustment to grade.

2.03 CEMENT MORTAR

A. Cement mortar: ASTM C270, Type M, fabricated with ASTM C150, Type IIA Portland Cement. Use cement mortar for brick and concrete work, grout collars for pipe connections to structures, lifting holes and other locations indicated in the Contract Documents.

2.04 NON-SHRINK GROUT

A. Non-metallic, fast setting, waterproof, non-shrink, cement-based.

B. Minimum compressive strength at 28 days: 5000 psi.

C. Minimum bond strength: As required to store full bond to reinforcing bars and concrete surfaces, but not less than 3000 psi at 7 days per ASTM C882.

D. Wire Mesh Wrapping: 12 gauge galvanized steel; 2 inches square welded grid pattern.

E. Bonding Agent: Solvent-free moisture-insensitive structural epoxy adhesive; recommended for bonding fresh concrete or repair mortar to steel or hardened concrete.

2.05 FRAMES, COVERS, AND GRATINGS FOR DRAINAGE STRUCTURES

A. Frames, Grates, and Covers: ASTM A48, Class 30, cast iron. Castings shall withstand H20 loadings requirements as defined in Caltrans Bridge Design Specifications.

B. Provide appropriate Caltrans standard grates for Caltrans standard inlets. Where standard inlets of a jurisdictional authority are used, provide frames, grates, and covers in accordance with that jurisdictional authority's standards.

C. Place concrete collars around all drainage structure castings.

2.06 TRENCH DRAINS AND DOWN SPOUTS

A. Trench Drain and Down Spout:

1. Trench drains on walking surface within station shall conform to ASME A112.6.3. Grate shall be perforated 304 or 316 stainless steel designed to be heel proof and meet ADA guidelines. The maximum slot opening size shall be ¼".

2. Trench drains out site of station shall conform to AASHTO M306. Grates in parking lots shall also comply with ADA guidelines with maximum slot opening size of ½". Gates shall be cast iron conforming to ASTM A48, or shall be constructed of ASTM A36 steel and hot dipped galvanized after fabrication.

3. Down spout pipe wall thickness: 0.12 inches

PART 3 - EXECUTION

3.01 PIPE INSTALLATION

A. General:

1. Perform trench excavation, backfill, and related earthwork as specified in Section 02300, Earthwork.

2. Examine each pipe prior to laying. Use no defective or damaged pipe. Lay pipe to the elevations, inverts, grades, and alignment as indicated on the Contract Drawings.

3. Provide proper equipment for lowering sections of pipe into trenches.

4. Under no circumstances lay pipe in water. Do not lay pipe when trench conditions or weather are unsuitable for such work.

B. Laying Pipe:

1. Lay corrugated metal pipe with the outside laps of circumferential joints pointing upstream and with longitudinal laps on the sides. Cut pipe requiring cutting by mechanical means only (no torch burning or cutting is allowed). Remove burrs and ragged edges from edges of cut pipe.

2. Lay pipe upgrade, unless otherwise noted.

C. Joining Pipe:

1. Lay drainage pipe with the separate sections joined firmly together.

2. Keep the space between the pipe and connecting bands or joints free from dirt and grit so that the connections fit snugly.

3. Protect jointing materials from the air and sun to prevent drying or deterioration.

4. Join PVC pipe in accordance with ASTM D2855.

D. Repair or Replacement of Pipe:

1. Repair bituminous coating on corrugated metal pipe and connecting bands that has been damaged or scored during culvert installation equal to original coating prior to backfilling. Make repairs in accordance with the manufacturer's specifications.

2. Remove and replace pipe which has been damaged to such extent that satisfactory field repairs cannot be made.

3.02 DRAINAGE STRUCTURES

A. Set drainage structures in the proper location at the invert elevations indicated on the Contract Drawings with rim at the proper elevation. Set structures plumb and true on well compacted gravel base. Provide for adjustment of frames and covers using precast concrete rings or bricks, with a cement mortar or non-shrink grout to close the opening between the frame and structure. Under no condition remove a portion of the structure to allow adjustment of the frame and cover or grate to the proper grade.

B. Install precast reinforced concrete drainage structures in a manner to ensure watertight construction. Repair or replace precast concrete units as required to obtain watertight construction. Install risers and tops using approved gaskets for sealing joints. Install units level and plumb. Prevent water from rising over newly made joints until after joints have been inspected and accepted. Make joints watertight.

C. Perform field cutting of openings in the precast utility structure risers so as not to damage the riser. Replace damaged risers. Install risers and tops with the steps in alignment.

D. Install catch basins so as to preclude sediment from any tributary areas from entering the basins until such areas have been stabilized.

E. Where new pipe manholes or pipe inlets are located in areas to be paved or surfaced, construct no individual structure to final grade until the paving or surfacing has been completed immediately adjacent to said structure.

3.03 EXISTING DRAINAGE SYSTEMS

A. Cleanly cut new openings in existing drainage structures, to accept new pipe. Carefully install the new piping and join the new pipe to the existing structure. Make connection using an appropriate saddle where indicated in the Contract Drawings, or grouted as required to provide a neat, sturdy, watertight connection. Make connection in accordance with the standards of the agency having jurisdiction over storm drainage system. Repair any existing or new pipes or structures damaged as a result of the Contractor's work.

B. Seal abandoned storm drain lines which are not removed with masonry plugs.

C. Modify existing storm drain manhole as shown in the Contract Drawings by removing and reconstructing portion of the structure to match the new grade line. Replace frames and covers as required.

D. Modify existing storm drain inlet to manhole as shown in the Contract Drawings by removing and reconstructing portion of the structure and constructing new frame and grate to match the new grade line.

END OF SECTION

SECTION 02650

PRECAST CONCRETE CULVERTS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes specifications for concrete three-sided arch culverts with headwalls and wingwalls. Headwalls and wingwalls may be precast or cast-in-place.

1.02 REFERENCE STANDARDS

A. American Railroad Equipment and Maintenance-of-way Association (AREMA):

1. Manual for Railway Engineering and Maintenance

B. ASTM International (ASTM):

1. C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

2. C497 Standard Test Methods for Concrete Pipe, Concrete Box Sections, Manhole Sections, or Tile

C. Caltrain Standards for Design and Maintenance of Structures

1.03 DESIGN REQUIREMENTS

A. Comply with requirements indicated in the Contract Documents.

1.04 SUBMITTALS

A. Shop Drawings. Submit shop drawings for Engineer's approval including the following information for footings, culvert section, wingwalls, and headwalls, as applicable:

1. Concrete dimensions, elevations, and reinforcing steel with bar size and spacing indicated. Include elevation, plan, and section views. Include anchorage details, as applicable.

2. Details for pedestals.

3. Note actual soil bearing pressure on the footing detail sheets.

4. Structure backfill type and limits for culvert and wingwalls.

B. Submit manufacturer's product data of the culvert system for approval. Include adhesive for securing plugs in handling holes.

C. Submit sample showing proposed wingwall finish.

D. Submit design computations for culverts including wingwalls and pedestals. Furnish a longhand example of the design methodology if the design calculations are in a computer printout format.

1.05 QUALITY ASSURANCE

A. Design computations and shop drawings shall be signed and sealed by a professional engineer registered in the State of California.

PART 2 – PRODUCTS

2.01 GENERAL

A. All products necessary to complete the work shall conform to the relevant sections of these technical specifications.

B. Sealer and Waterproofing Membrane: As recommended by culvert manufacturer and approved by the Engineer.

2.02 FABRICATION

A. Handling devices or holes will be permitted in each culvert or wingwall section. However, not more than four holes shall be cast or drilled in each section. Cast holes shall be tapered.

B. Design and form section ends so that when the culvert sections are erected, they shall make a continuous line of culvert with a smooth interior free of irregularities.

C. Joints: Provide keyway joints between culvert sections. Keyway joint shall be a minimum of 4 inches deep by 1-1/2 inches wide.

D. The culvert sections and wingwalls shall be free of fractures. The ends of the culvert sections shall be normal to the walls and centerline, except where beveled ends are specified. The surface of the culvert section shall be a smooth steel form or troweled surface. Trapped air pockets causing defects which do not weaken or make sections more vulnerable to corrosion shall be considered as part of a smooth steel form finish.

E. Provide smooth rubbed finish on wingwalls. Refer to Section 03170, Concrete Finishing.

F. Do not store culvert units in an upright position until the designated handling and storage compressive strength, as shown on the shop drawings, has been achieved.

G. Marking: Clearly mark each culvert section and wingwall with waterproof paint. The following information shall be shown on the inside face of each wingwall and on a vertical leg of each culvert section:

1. Culvert span and rise (culvert sections only)

2. Date of manufacture

3. Name or trademark of manufacturer

4. Design earth cover

5. Location designator for use in field

2.03 SOURCE QUALITY CONTROL

A. Test Specimen: Determine concrete compressive strength from compression tests made on cylinders or cores. For cylinder testing, take a minimum of 4 cylinders during each production run. For core testing, cut one core from a culvert section selected at random from each group of 15 culvert sections or less of a particular size and production run. Cut one core from each group of four or fewer wingwalls. For each continuous production run, each group of 15 culvert sections of a single size or fraction thereof or four wingwalls shall be considered separately for the purpose of testing or acceptance. A production run shall be considered continuous if not interrupted for more than three consecutive days.

B. Compression Testing: Make and test cylinders in accordance with ASTM C39. Obtain cores and test for compressive strength in accordance with ASTM C497.

C. Acceptability of Cylinders Tests: Failure of one of the 28 day test cylinders to achieve 90 percent of the minimum compressive strength requirement may be cause for rejection.

D. Acceptability of Core Tests: The compressive strength of the concrete in each group of sections as defined above will be acceptable when the core test strength is equal to or greater than the design concrete strength. The Engineer will randomly select and witness testing of the cores taken by the manufacturer.

E. If compressive strength of a core is less than the design concrete strength, the culvert section or wingwalls from which that core was taken will be rejected. The Engineer will select two culvert sections or wingwalls from the remainder of the group at random, and one core shall be taken from each. If the compressive strength of both cores is equal to or greater than the design concrete strength, the remainder of the culvert sections or wingwalls in that group will be acceptable. If the compressive strength of either of the two cores tested is less than the design concrete strength, the remainder of the culvert sections or wingwalls in the group will be rejected. However, at the option of the manufacturer, each remaining culvert section or wingwall in the remainder of the group may be cored and accepted individually. The sections which have cores with less than the design concrete strength will be rejected.

F. Plugging Core Holes in Accepted Units: Plug and cure core holes at place of manufacture in such a manner that the culvert will meet all the test requirements of the specifications. Culvert sections or wingwalls repaired accordingly will be considered satisfactory for use.

G. Test Equipment: Furnish facilities and personnel necessary to conduct the quality control tests required.

2.04 INSPECTION

A. Rejection: Culvert sections or wingwalls will also be rejected due to the following conditions.

1. Fractures or cracks pass through the wall, except for a single end crack which does not exceed half of the thickness of the wall.

2. Defects which indicate proportioning, mixing, or molding which are not in accordance with specifications.

3. Honeycombed or open texture.

4. Damaged section ends, where such damage prevents making a satisfactory joint.

2.05 REPAIRS

A. Repair or replace culvert sections and wingwalls which have manufacturing imperfections or have been damaged. Repairs shall be sound, properly finished and cured, and repaired culvert section or wingwalls complies with the requirements specified herein.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Bottom of Trench Compaction: Compact soils in the bottom of the excavation to 95 percent of the maximum dry density. If 95 percent of the maximum dry density cannot be obtained in the bottom of the excavation or in other areas or if soft soils are encountered at depths that make removal impractical, contact the Engineer for additional requirements.

B. Footings: Footings may be cast-in-place or precast. When a precast footing is utilized, a four (4) inch layer of pervious backfill shall be placed under the full width of the footing. Give footings a smooth form finish. The footing concrete shall reach a compressive strength indicated on the shop drawings before placement of the culvert sections or wingwalls.

C. Pedestals: When a cast-in-place reinforced concrete pedestal is required between the base of the culvert leg and the top of the footing, either provide a culvert with longer legs or construct pedestals, at the Contractor's option.

D. Placement of Culvert Sections and Wingwalls: Set culvert sections and wingwalls on masonite or steel shims. Provide a minimum gap of 1/2 inch between footing and bottom of each section or wingwall. Fill gap with a slurry cement backfill in accordance with Section 02300, Earthwork.

E. Sealing: Apply sealer on the top surface of the culvert section. Such sealer shall extend 5 feet vertically down each vertical leg. Place no sealer material in keyway joints. Provide sealer for the full length of the structure. Prepare surface and apply sealer as recommended by sealer manufacturer.

F. Keep waterproofing membrane in its proper location over joints and protect from damage during the backfilling operation.

G. Prior to backfilling, treat handling holes as follows: Fill tapered holes for handling with Portland cement mortar or precast concrete plugs secured with Portland cement mortar or other adhesive, as approved. Fill drilled holes for handling filled with Portland cement mortar. Prior to backfilling the structure, cover holes with waterproofing membrane with a minimum width of 9 inches.

H. Place and compact structure backfill as specified in Section 02300, Earthwork.

END OF SECTION

SECTION 02700

STATION PLATFORMS, SIDEWALKS, CURBS AND GUTTERS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes requirements for cast-in-place concrete station platforms, sidewalks, curbs, gutters, driveways, island paving, and curb ramps, and for installing detectable warning surfaces in sidewalk ramps on streets.

1.02 REFERENCE STANDARDS

A. Standard Specifications for Public Works Construction (SSPWC):

1. Section 201 Concrete, Mortar, and Related Materials

2. Section 303-5 Concrete Curbs, Walks, Gutters, Cross Gutters, Alley Intersections, Access Ramps, and Driveways

B. State of California, Department of Transportation, Standard Specifications (Caltrans):

1. Section 51 Concrete Structures

2. Section 90 Concrete

3. Section 73 Concrete Curbs and Sidewalks

1.03 SUBMITTALS

A. Submit concrete mix designs as specified under Section 03300, Cast-in-Place Concrete.

B. For station platforms, comply with the submittal requirements specified in Section 03200, Concrete Reinforcing, Section 03300, Cast-In-Place Concrete, and Section 03160, Colored Concrete.

1.04 DELIVERABLES

A. For station platforms, comply with the deliverable requirements specified in Section 03200, Concrete Reinforcing and Section 03300, Cast-In-Place Concrete.

B. At sidewalk ramps, perform a preconstruction survey to verify that forms and site constraints will allow the design dimensioning and slope requirements to be achieved. Upon completing construction of these facilities, perform a post construction survey and verify that design dimensioning and slope requirements were achieved. The post construction survey must include a minimum of 3 measurements for each dimension and slope requirement shown. Individual measurements must be equally distributed across the specified slope or dimensional surface. Within 2 business days of performing the surveys, submit

preconstruction and post construction surveys signed and sealed by one of the following:

1. Land surveyor registered in the State.

2. Civil engineer registered in the State.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Sidewalks, Medians, Driveways, Curbs, and Gutters: Materials shall be as specified in SSPWC, Section 201, and as otherwise specified herein.

B. Station Platforms: Materials shall be as specified in Section 03300, Cast-in-Place Concrete, including polypropylene fibers. Concrete shall be integrally colored in accordance with Section 03160, Colored Concrete. Color shall match Quality Concrete Integral Color "Satin Gray", unless otherwise indicated in the Contract Documents.

C. Type A Joint Seal Material: As specified in Caltrans Standard Specifications, Section 51-2.02B, or conform to ASTM C920 (Type S or M, Class 25, Use T).

D. Joint Sealant for Station Platforms: Joint sealants shall be type specified in Section 07250, Joint Sealants. Provide in color to match colored concrete.

E. Moisture Barrier for Contact Joints: Curing compound, conforming to requirements in Caltrans Standard Specifications, Section 90-1.03B(3), Curing Compound Method.

F. Formwork: As specified in SSPWC, Section 303-5, except as otherwise required by the jurisdictional authority.

G. Reinforcing: Refer to Section 03200, Concrete Reinforcement, for reinforcement of station platforms and concrete pavement, as applicable.

H. Detectable Warning Surface material for sidewalk ramps on streets must be shown on the Caltrans Authorized Material List for detectable warning surface and must comply with yellow color no. 33538 of FED-STD-595.

PART 3 - EXECUTION

3.01 GENERAL

A. Construct in accordance with SSPWC, Section 303-5, except as otherwise required by the jurisdictional authority and as otherwise specified herein.

B. Construct station platforms as specified in Section 03160, Colored Concrete.

3.02 SUBGRADE

A. Perform in accordance with the requirements of Section 02300, Earthwork, and the following:

1. Immediately prior to placing concrete, subgrade to receive pavement shall conform to compaction and elevation tolerances specified for the material involved.

2. Construct true to grade and cross sections, thoroughly water and roll, or hand tamp until hard and solid. Remove soft, spongy or other unsuitable material to provide stable subgrade at least 6 inches below required subgrade elevation. Deposit approved fill material in low areas, compact thoroughly and grade to required finish subgrade elevation.

3. Subgrade shall be uniformly moist, and any excess water standing in pools or flowing on the surface shall be removed prior to placing concrete.

B. Provide templates for testing grade and cross section of subgrade. Extend template full width between forms and support on side forms.

3.03 CONTACT JOINTS

A. Contact joints are those made by placing fresh concrete against hardened concrete. Apply moisture barrier to the face of contact joint and allow to dry prior to placing fresh concrete against that joint face.

3.04 CURB CONSTRUCTION

A. Construct top and face of the finished curb true and straight. Construct top surface of curbs a uniform width, free from humps, sags, or other irregularities. When a straightedge 10 feet long is laid on the top face of the curb or on the surface of gutters, the surface shall not vary more than 1/8 inches from the edge of the straightedge, except at grade changes or curves.

3.05 SIDWALK AND RAMP CONSTRUCTION

A. Before placing concrete, verify that forms and site constraints allow the required dimensioning and slopes shown. Immediately notify the Engineer if you encounter site conditions that will not accommodate the design details.

END OF SECTION

SECTION 02720
ASPHALT PAVING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for hot-mix asphalt concrete (HMAC) track underlayment and asphalt concrete (AC) paving. Track underlayment includes all areas under the track, and the HMAC becomes part of the track structure.

1.02 REFERENCE STANDARDS

A. State of California, Department of Transportation, Standard Specifications (Caltrans):

1. Section 39 Asphalt Concrete
2. Section 92 Asphalt Binders
3. Section 94 Asphaltic Emulsions
4. Section 96 Geosynthetics

1.03 SUBMITTALS

A. Submit Certificate of Compliance confirming that the asphalt concrete mix is in accordance with the requirements of this Section.

B. List of equipment to be used for the placing, spreading, and compaction of asphalt paving on structures. Only equipment approved by the Engineer shall be used.

C. Mix Design: Submit proposed mix design for each asphaltic concrete mixture and seal coat to be used in the work, covering the specific materials to be used in the mixes. Include test data in support of each proposed mix design.

D. Quality Control Plan: Include description of the organization and procedures for controlling HMA quality characteristics, taking samples, including sampling locations, establishing, implementing, and maintaining QC, determining when corrective actions are needed, implementing corrective actions, and using methods and materials for backfilling core locations. The QC plan must also address the elements affecting HMA quality, including aggregates, asphalt binder, additives, production, and paving.

1.04 DELIVERABLES

A. Submit records of delivery of asphalt materials, identifying shipment numbers, dates and quantities, material designations and temperature at the time of placement.

B. Submit test results of aggregate tests, and mix design verification tests.

C. Submit test results of sampling and testing, and inspection records within 24 hours of asphalt concrete placement.

PART 1 – PRODUCTS

2.01 MATERIALS

A. The material for HMAC and AC pavements shall conform to the provisions of Caltrans Standard Specifications, Section 39-2, Hot Mix Asphalt.

B. HMAC pavement for track underlay: Type A HMA with 3/4-inch maximum, coarse aggregate gradation. Asphalt binder shall be PG64-28PM grade in accordance with Section 92 of the Caltrans Standard Specifications.

C. AC pavement: Type A HMA with 1/2-inch maximum, coarse aggregate gradation. Asphalt binder shall be steam refined PG64-16 grade in accordance with Section 92 of the Caltrans Standard Specifications.

D. Tack coat shall be Type SS-1 conforming to the provisions of the American Asphalt Institute Specifications and Caltrans Standard Specifications, Section 94, Asphaltic Emulsions.

E. Pavement Reinforcing Fabric: Caltrans Standard Specifications, Section 96, Geosynthetics.

PART 3 – EXECUTION

3.01 PREPARATION

A. HMAC pavement for track underlay: Subgrade shall be prepared and compacted to the requirements of Section 02300, Earthwork. Confirm that immediately prior to spreading HMAC, the subgrade to receive HMAC conforms to the compaction and elevation tolerances indicated and is free of standing water and loose or extraneous material. Request Engineer's inspection of and obtain Engineer's written acceptance of the prepared subgrade before proceeding with the spreading of HMAC

B. Obtain written approval of aggregate base course from the Engineer prior to proceeding with paving. Refer to Section 02310, Aggregate Base Courses.

C. Refer to Section 02510, Utility Grade Adjustments, for related work.

3.02 SPREADING

A. Spread HMAC underlay by either a mechanical spreader or a grader. Maximum length of asphalt mixture placed by an approved mechanical spreader in a continuous strip shall not exceed 800 feet, unless otherwise permitted by the Engineer. Lay adjacent strips subject to the above limitations immediately after the previous strip is placed until the full pavement width has been achieved.

B. Place pavement to the depth shown on the Contract Drawings. Lift thickness shall conform to the following:

1. Final Surface Course or Lift: In areas subject to vehicular traffic, the maximum thickness shall be 2 inches. In all other areas, the maximum thickness shall be 3 inches.

2. Lifts Other Than Final: The maximum thickness shall be 3 inches.

C. Use a paver or approved mechanical spreader. Obtain Engineer's approval for use of other means of spreading and compaction.

D. Apply tack coat prior to placing asphalt concrete in accordance to Caltrans Standard Specifications, Section 39-2.

E. Hand Laying Surface Mixture: Dump on approved dumping boards or steel plates and distribute immediately by means of hot shovels. Uniformly spread by means of hot iron rakes with tines not less than 1/2 inch longer than the loose depth of mixture to a depth which, after final compaction, shall be of the thickness required. Permit no walking on the surface mixture during the laying operations. If laid by hand, carefully lute surface mixture, after spreading and raking, from the sides before compaction.

3.03 COMPACTION

A. Rollers:

1. Steel-wheeled, tandem type power driven rollers shall provide a pressure of not less than 225 pounds per inch width of main roll. Rolls shall be smooth and without flat spots or other imperfections.

2. Pneumatic rubber-tired rollers shall be self-propelled with wheels mounted, grouped and spaced to provide uniform coverage with each pass. Rear group wheels shall not follow in the tracks of forward group wheel. Maximum wheel load shall be 5,600 pounds. Tire compression on pavement, where the area of contact is measured on a hard, unyielding surface, shall be 80 psi plus five (5) psi for each wheel. The total maximum load per axle, whether single axle or a group of axles in the same alignment, shall be 22,400 pounds. Wheel loads and tire pressures shall be controlled to produce the required degree of compaction without rutting of the surface to be rolled.

B. Rolling:

1. Proceed continuously at the following rates:

a. For track underlay mixture, when spread by hand, not in excess of 400 square yards per hour, per roller.

b. For track underlay, when spread by machine, not in excess of 600 square yards per hour, per roller.

c. For asphalt concrete surface mixtures, when spread by hand, not in excess of 300 square yards per hour, per roller.

d. For asphalt concrete surface mixtures, when spread by machine, not in excess of 400 square yards per hour, per roller.

2. Immediately after spreading, thoroughly compact by approved tamping irons adjacent to curbs, manholes and rails, by rolling with approved rollers continuously from commencement to final completion at a speed not exceeding three (3) miles per hour.

3. Make initial rolling, using tandem type rollers, parallel to the center line of the paved surface beginning at the curbs or edges of the paved surface and working toward the center, overlapping on successive trips by one-half the rear wheel of the roller. Immediately following the initial rolling, further compact by pneumatic rubber-tired rollers or steel wheel vibratory tandem type rollers a minimum of eight (8) passes, except HMAC track underlay which shall receive 4 passes. Smooth shallow ruts and ridges with tandem rollers immediately following the rubber-tired rolling.

4. First make final roll longitudinally with the paved surface and then diagonally or at right angles. Continue until no further compression results; the mixture has cooled; no marks show under the roller; and the surface is smooth and free from depressions, waves, bunches, and unevenness.

5. Test after the mixture has been rolled with an approved straight edge and surface testing machine laid parallel to the centerline of the paved surface.

3.04 JOINTS

A. Lay surface mixture in a continuous operation and pass the roller over the unprotected end of the freshly laid mixture only when laying of the course is to be discontinued for such length of time as to permit the mixture to become chilled. Provide for proper bond with new mixture by cutting or trimming back the joint to expose an unsealed or granular surface for the full specified depth of the course.

B. At the end of each day's work, form joints by laying and rolling against boards of the thickness of the compacted mixture, placed across the entire width of the pavement.

C. When the laying of the mixture is resumed, remove the boards, apply tack coat to the exposed edge of the joint, rake a fresh mixture against the joint, thoroughly tamp and roll. Hot smoothing irons may be used for sealing joints.

3.05 LAYING IN DAYLIGHT, WET WEATHER, COLD WEATHER

A. Schedule placement of asphalt paving material when the precipitation probability within 3 hours prior to the start of such operations is less than 50 percent.

B. Laying of mixtures will not be permitted in wet weather.

C. Except where otherwise permitted by the Engineer, spread no asphaltic mixtures when the asphalt mixture temperature is below 250 degrees F.

D. The Engineer will take surface temperatures at three (3) locations in the area being paved. The controlling temperature shall be the average of the three (3) readings.

3.06 OPENING TO TRAFFIC

A. Repair damage to new pavement caused by construction equipment or by public traffic due to premature opening of the traffic lanes to the satisfaction of the Engineer.

3.07 SURFACE PREPARATION

A. When pavement overlay or new pavement is to be constructed on an existing asphalt concrete, concrete, or brick surface, broom the existing surface clean prior to the application of prime coat. Repair holes and depressions in existing surfaces by removal to sound material and replacing with an asphalt-aggregate patching material. Compact the patch to produce a tight surface conforming to the adjacent pavement area. Stabilize rocking Portland cement concrete slabs by undersealing or cracking and seating. Make the necessary repairs before brooming and prime coating. Fill wide joints and cracks with asphaltic concrete/sand mix material and compact as required by the Engineer.

3.08 DEFECTIVE WEARING COURSE

A. Remove portions of the completed wearing course that are defective in finish, compression, composition, or density and replace with suitable material properly laid in accordance with these Specifications.

END OF SECTION

SECTION 02725
MICROSURFACING

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section Includes specifications for microsurfacing.

1.02 REFERENCE STANDARDS

A. State of California, Department of Transportation, Standard Specifications (Caltrans):

1. Section 39 Asphalt Concrete

2. Section 96 Geosynthetics

3. Section 94 Asphaltic Emulsions

1.03 DEFINITIONS

A. Microsurfacing: a mixture of polymer-modified asphalt emulsion, mineral aggregate, mineral filler, water, and other additives, properly proportioned, mixed and spread on a paved surface in accordance with these specification.

1.04 SUBMITTALS

A. Submit a mix design and a mix design report of laboratory tests performed for the micro-surfacing materials. A representative of the laboratory performing the mix design and tests must sign the report. The Engineer reviews and approves the submittal before starting micro-surfacing. Do not substitute materials after the mix design is approved unless the substitute materials are laboratory-tested and a new mix design and report are submitted. Do not use substitute materials until the Engineer approves the mix design for those materials.

B. Submit a Certificate of Compliance with each emulsion shipment as specified for asphaltic emulsion in Section 94 of the Caltrans Standard Specifications.

C. Before micro-surfacing activities start, submit the name of a person authorized to communicate with the Engineer about days when unsuitable weather conditions prevent micro-surfacing.

1.05 REQUIREMENTS

A. Contractor shall apply microsurfacing in the limit as shown on the Plans. The mix type is to be a quick-traffic system, meaning that it will accept traffic after a short period of time.

B. Trucks shall maintain current approved overweight permits in said trucks. The contractor shall obtain an extra legal load permit from the applicable cities/county for microsurfacing vehicles. Contractor shall place a copy of the

permit in all applicable vehicles used. The extra legal load permit shall contain a waiver of the reducible load requirements.

C. Prior to any paving operations, there shall be a pre-Microsurface Overlay meeting 10 days before starting microsurfacing work with the Engineer, Inspector, Materials Lab Inspector and Contractor's Representative to discuss pavement scope and strategies.

D. Post Microsurface overlay all flexible temporary markers, "floppies", shall be cut flush with pavement.

E. The roadway shall not be striped before 5 calendar days of microsurfacing curing, but shall be striped within 10 calendar days after the completion of paving.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Emulsified Asphalt

1. The emulsified asphalt and asphalt residue shall be ASTM D2397 and Table 4 in Section 94 of State Standard Specifications for CQS-1h. The cement mixing test shall be waived for this emulsion.

2. Emulsion shall be stored in an uncontaminated (clean) container. Said clean containers shall be locked. If an uncontaminated container is unavailable Emulsion shall be stored in clean trucks.

3. The polymer material shall be milled or blended into the asphalt or emulsifier solution prior to the emulsification process. The minimum amount and type of polymer modifier shall be determined by the laboratory performing the mix design. The minimum amount required will be based on asphalt weight content and will be certified by the emulsion supplier. A three percent (3%) polymer solids, based on asphalt weight, is considered minimum.

4. The five-day (5) settlement test may be waived, provided job stored emulsion is used within thirty-six (36) hours from the time of the shipment, or the stored material has had additional emulsion blended into it prior to use.

5. When tested according to the following tests, the emulsion shall meet the requirements of ASTM D2397 and Table 4 in Section 94 of State Standard Specifications for CQS-1h, listed below:

Type Grade Properties		Cationic CQS1 min	max	CQS1h min	max
Tests on emulsions:	Test Method	--			
Saybolt Furol Viscosity, @ 50 °C, SFS[a]	AASHTO T 59	15	90	15	90
Sieve test, %		--	0.30	--	0.30
Storage stability, 1 day, %		--	1	--	1
Residue by distillation, %		57	--	57	--
Particle charge[b]		positive		positive	
Tests on Residue from Distillation Test:	--	--			
Penetration, 25°C	AASHTO T 49	100	200	40	90
Ductility, 25°C, mm	AASHTO T 51	400	--	400	--
Solubility in trichloroeythylene, %	AASHTO T 44	97	--	97	--

[a]Means Saybolt Furol seconds
[b]If the result of the particle charge test is inconclusive, the asphaltic emulsion must be tested for pH under ASTM E 70. Grade CQS1h asphaltic emulsion must have a ph value between 6.7 and 7.3.

6. Each load of emulsified asphalt shall be accompanied with a Certificate of Analysis/Compliance to assure that it is the same as that used in the mix design.

B. Aggregate

1. The mineral aggregate used shall be Type II and grade specified for the particular use of the micro-surfacing. The aggregate shall be a manufactured crushed stone. Aggregate shall be 100% crushed gravel with no round particles and shall be free of lumps, oversize particles, vegetable matter and other deleterious substances. Aggregate can be black, gray or light colored. Aggregate for micro-surfacing excluding mineral filler must have the quality characteristics as specified in the following table:

AASHTO TEST NO.	**ASTM TEST NO.**	**CTM**	**QUALITY**	**SPECIFICATION**
AASHTO T176	ASTM D2419	CT217	Sand Equivalent	65 Minimum
AASHTO T210	ASTM D3744	CT229	Durability Index	65 Minimum
		CT205	Crushed Particles[a]	95% Minimum
AASHTO T96	ASTM C131	CT211	Abrasion Resistance[b]	35% Maximum

[a]Crushed particles must have at least 1 fractured face.
[b]California Test 211 must be performed on the aggregate before crushing.

2. The abrasion test is to be run on the parent aggregate. The aggregate should meet state approved polishing values. Proven performance may justify the use of aggregates that may not pass all of the above tests. No single aggregate grading or Sand Equivalent test shall represent more than 300 tons or one day's production, whichever is smaller.

C. Grading

1. Aggregate shall have a jobsite stockpile for gradation testing. Aggregate must have the following gradation as determined under California Test 202:

SIEVE SIZE	**TYPE II PERCENT PASSING**	**STOCKPILE TOLERANCE**
3/8 (9.5 mm)	100	
# 4 (4.75 mm)	94 - 100	± 5%
# 8 (2.36 mm)	65 - 90	± 5%
# 16 (1.18 mm)	40 - 70	± 5%
# 30 (600 um)	25 – 50	± 5%
#200 (75 um)	5 - 15	± 2%

2. Aggregate must be rock dust or sand such as plaster sand. Aggregate larger than the no. 50 sieve must be 100 percent crushed rock. Aggregate must be free from vegetable matter, deleterious substances, caked or clay lumps, and oversized particles. The job mix (target) gradation shall be within the gradation band for the desired type. After the target gradation has been submitted (this should be the gradation that the mix design is based on), then the percent passing each sieve shall not vary by more than the stockpile tolerance shown in the above table for each individual sieve, and still remain within the gradation band. The percent passing shall not go from the high end to the low end of the range for any two consecutive screens.

3. The aggregate will be accepted at the job location stockpile or when loading into the support units for delivery to the lay-down machine. The stockpile shall be accepted based on five gradation tests according to California Test 202. If the average of the five tests is within the gradation tolerances, then the materials will be accepted. If the tests show the material to be out, the contractor will be given the choice to either remove the material or blend other aggregate with the stockpiled material to bring it into specification. Materials used in blending must meet the quality tests before blending and must be blended in a manner to produce a consistent gradation. If blending is used, it will require that a new mix design be performed.

4. Screening shall be required at the stockpile prior to delivery to the paving machine if there are any problems created by having oversize material in the mix.

D. Mineral Filler

1. Mineral filler must be portland cement of any combination of Type I, Type II, or Type III cement. It may be accepted upon visual inspection. The type and amount of mineral filler needed shall be determined by a laboratory mix design and will be considered as part of the aggregate gradation. An increase or decrease of less than one percent (1%) may be permitted when the Micro-surfacing is being placed if it is found to be necessary for better consistency or set times.

E. Water

1. The water shall be potable and free of harmful soluble salts or reactive chemicals and any other contaminants.

F. Additives

1. Additives may be added to the emulsion mix or any of the component materials to provide the control of the quick-traffic properties. They must be included as part of the mix design and be compatible with the other components of the mix.

G. Mix Design

1. The contractor shall submit to the Engineer for approval a complete mix design prepared and certified by a laboratory which has experience in designing micro-surfacing. Compatibility of the aggregate, polymer-modified emulsion, mineral filler, and other additives shall be verified by the mix design. The mix design shall be made with the same aggregate gradation that the contractor will provide on the project. After the mix design has been approved, no substitution will be permitted, unless approved by the Engineer. Recommended tests and values are as follows:

ISSA TEST NO.	DESCRIPTION	SPECIFICATION
ISSA TB-139	Wet Cohesion @ 30 Minutes Minimum (Set) @ 60 Minutes Minimum (Traffic)	 12 kg-cm Minimum 20 kg-cm Minimum or Near Spin
ISSA TB109	Excess Asphalt by LWT Sand Adhesion	50 g/ft2 Maximum (538 g/m2 Maximum)
ISSA TB-114	Wet Stripping	Pass (90% Minimum)
ISSA TB-100	Wet-Track Abrasion Loss One-hour Soak Six-day Soak	 50 g/ft2 (538 g/m2) Max. 75 g/ft2 (807 g/m2) Max.

2. The wet-track abrasion tests are used to determine the minimum asphalt content and resistance to stripping. Some systems require longer times for the asphalt to adhere to the stone. In these systems, a modified Marshall Stability Test (ISSA TB-148) or Hveem Cohesiometer Test (ASTM D 1560) has been used to confirm asphalt content.

ISSA TEST NO.	DESCRIPTION	SPECIFICATION
ISSA TB-147	Lateral Displacement Specific Gravity after 1,000 Cycles of 25 Pounds (11.34 kg)	5% Maximum 2.10 Maximum
ISSA TB-144	Classification Compatibility	11 Grade Points Minimum (AAA, BAA)
ISSA TB-113	Mix Time @ 77oF (25oC)	Controllable to 120 Seconds Minimum

3. The mixing test is used to predict how long the material can be mixed in the machines before it begins to break. It is more for information to be used by the contractor than for quality of the end product.

4. The mixing test and set-time test should be checked at the highest temperatures expected during construction.

5. The mix design should report the quantitative effects of moisture content on the unit weight of the aggregate (bulking effect). The report must clearly show the proportions of aggregate, mineral filler (minimum and maximum), water (minimum and maximum), additive usage, and polymer-modified asphalt emulsion based on the dry weight of the aggregate.

6. All the component materials used in the mix design shall be representative of the materials proposed by the contractor to be used on the project.

7. The percentages of each individual material required shall be shown in the laboratory report. Adjustments may be required during construction, based on field conditions. The Engineer will give final approval for all such adjustments.

COMPONENT MATERIALS	**LIMITS**
Residual Asphalt	5.5 to 9.5% by dry weight of aggregate
Mineral Filler	0.0 to 3% by dry weight of aggregate
Polymer-Based Modifier	Minimum of 3% solids based on bitumen weight content
Additives	As needed
Water	As needed

H. Rate of Application

1. The Micro-surfacing mixture shall be of the proper consistency at all times, so as to provide the application rate required by the surface condition. The average single application rate shall be 15 lb/sy(+/-1 lb/sy)

2.02 EQUIPMENT

The contractor shall be responsible for providing adequate additional equipment to ensure planned production rate is met in the event there is a breakdown or rejection of equipment. All equipment, tools, and machines used in the performance of this work shall be maintained in satisfactory working condition at all times to ensure a high-quality product. Suitable surface preparation equipment, traffic control equipment, hand tools, and any other support and safety equipment shall be provided by the contractor as necessary to perform the work

A. Mixing Equipment

1. The machine shall be specifically designed and manufactured to lay micro-surfacing. The material shall be mixed by an automatic-sequenced, self-propelled micro-surfacing mixing machine, which shall be a continuous-flow mixing unit able to accurately deliver and proportion the aggregate, emulsified asphalt, mineral filler, control setting additive, and water to a revolving multi-blade, double-shafted mixer and to discharge the mixed product on a continuous-flow basis. The machine shall have sufficient storage capacity for aggregate, emulsified asphalt, mineral filler, control additive and water to maintain an adequate supply to the proportioning controls. On major highways,

the machine may be required to be a self-loading machine capable of loading materials while continuing to lay micro-surfacing, thereby minimizing construction joints. If used, the self-loading machine shall be equipped to allow the operator to have full control of the forward and reverse speeds during applications of the micro-surfacing material and be equipped with opposite-side driver stations to assist in alignment. The self-loading device, opposite-side driver stations, and forward and reverse speed controls shall be original equipment manufacturer design.

2. Truck mounted mixer-spreaders must proportion micro-surfacing materials by volume and mix them in continuous pugmill mixers. Before starting mixing and spreading activities, demonstrate:

   a. Rotating and reciprocating equipment are covered with metal guards.

   b. Indicators work and are visible while walking alongside the truck mounted mixerspreader.

   c. Low-flow and no-flow devices work.

   d. The aggregate feeder's drive shaft is equipped with a revolution counter that reads to the nearest 0.10 of a revolution.

3. Aggregate feeders must be connected directly to the drive on the emulsion pump. Truck mounted mixer-spreaders must display identifying numbers at least 3 inches in height on the front and rear of the truck. The emulsion storage tank must have a thermometer at the pump suction level measuring the MSE temperature to within 10 °F accuracy.

4. The belt feeder delivering aggregate to the pugmill must have a device monitoring the aggregate depth. The device must automatically shut down the power to the belt feeder if the aggregate depth is less than the target depth. If the aggregate delivery belt is not an integral part of the drive chain, a second device must detect belt movement by monitoring revolutions of the belt feeder. This second device must automatically shut down power to the belt feeder if movement is interrupted. For both devices, shutdown may be delayed 3 seconds from sensing to allow for normal fluctuations.

B. Proportioning Devices

1. Individual volume or weight controls for proportioning each material to be added to the mix (i.e. aggregate, mineral filler, emulsified asphalt, additive, and water) shall be provided and properly marked. These proportioning devices are used in material calibration and determining the material output at any time.

C. Spreading Equipment

1. The mixture shall be agitated and spread uniformly in the surfacing box by means of twinshafted paddles or spiral augers fixed in the spreader box. A front seal shall be provided to insure no loss of the mixture at the

road contact point. The rear seal shall act as a final strike-off and shall be adjustable. The spreader box and rear strike-off shall be so designed and operated that a uniform consistency is achieved to produce a free flow of material to the rear strike-off. The spreader box shall have suitable means provided to side shift the box to compensate for variations in the pavement geometry.

2. The spreader box must have a series of strike-off devices at its rear.

   The leading strike-off device must be:

   a. Fabricated of a suitable material such as steel or stiff rubber

   b. Designed to maintain close contact with the pavement during spreading

   c. Capable of obtaining the specified thickness

   d. Capable of being adjusted to the various pavement cross sections

   The final strike-off device must be:

   a. Fabricated of flexible material that produces a uniform texture in the finished surface

   b. Cleaned daily and changed if longitudinal scouring occurs in the micro-surfacing

D. Calibration

1. Each mixing unit to be used in the performance of the work shall be calibrated in the presence of the Engineer prior to construction with project specific material. No machine will be allowed to work on the project until the calibration has been completed and accepted. Calibration sheet is to be kept in every truck so certified.

2. On a daily basis during micro-surfacing placement, gate settings for each truck used are to be recorded and approved by both the project inspector and the contractor's foreman, noting truck, time and any changes from previous setting

3. Periodic calibration checks ("Spot Checks") may be made by the Engineer at random intervals and is required to ensure machine project performance and compliance. Any truck found to have defective material measurement devices shall not be used on the job until it is repaired and recalibrated. Also, if a spot check shows a truck to be out of tolerance by 10% or more, the truck shall not be used until it is recalibrated. Spot check testing is not used for Payment purposes.

4. Spot Check Method: for 1 complete truck load of mix, the actual area placed is measured and noted. The amount of material placed is noted,

as indicated on that truck's measurement devices (e.g. number of turns of auger). The resulting pounds per area shall be 15 lb/sy(+/-1 lb/sy).

5. Spot Check Frequency: One Test shall be performed per truck per day.

PART 3 - EXECUTION

3.01 APPLICATION

A. When required by local conditions, the surface shall be pre-wetted by fogging ahead of the spreader box. The rate of application of the fog spray shall be adjusted during the day to suit temperatures, surface texture, humidity, and dryness of the pavement.

B. Using the approved mix design, proportion the micro-surfacing materials by volume. Field conditions may require adjustments during construction. Obtain the Engineer's approval before adjusting proportions. A belt feeder with an adjustable cutoff gate must proportion aggregate. The gate opening height must be determinable. For the aggregate belt feeder, the delivery rate for any individual check run must not deviate more than 2 percent from the average of the rates of 3 runs of at least 3 tons each. For the emulsion pump, the delivery rate for any individual check run must not deviate more than 2 percent from the average of the rates of 3 runs of at least 300 gallons each.

C. The micro-surfacing shall be of the desired consistency upon leaving the mixer. A sufficient amount of material shall be carried in all parts of the spreader at all times so that a complete coverage is obtained. Overloading of the spreader shall be avoided. No lumping, balling, or unmixed aggregate shall be permitted.

D. Micro-surfacing application shall be stopped to allow sufficient time for curing, installation of temporary or permanent pavement delineation and removal all traffic control before the end of working hours. The expressway shall be completely opened to traffic at the end of working hours. Micro-surfacing around manhole cover and utility cover shall be squeegeed flush with the rim or feathered out around the cover.

E. Gutter spills shall be cleaned immediately.

F. Micro-surfacing shall be applied within one foot of either side of railroad tracks, but not in the track area at railroad grade crossings.

G. Within twenty five (25) feet before and after commercial driveways and intersections, contractor shall add extra cement to the mix to prevent damage.

H. No streaks, such as those caused by dragging oversized aggregate, shall be left in the finished surface. If excess streaking develops, the job will be stopped until the contractor proves to the Engineer that the situation has been corrected. Excessive streaking is defined as more than four drag marks greater than one-half (1/2) inch wide (12.7 mm) and four inches (4) long (101 mm), or one inch (1) wide (25.4 mm) and three (3) inches long (76.2 mm), in any 29.9 yd2 (25 m2) area. No transverse ripples or longitudinal streaks of one-fourth (1/4) inch in depth (6.4 mm) will be permitted, when measured by placing a ten (10) foot (3 m) straight edge over the surface. The straight-edge measuring devise shall be

provided by the contractor and available for each day of operation. The Engineer will determine areas to be checked in the presence of the contractor. All areas found to be in need of correction, shall be repaired within 48 hours. All work associated with straight-edge checking and repair work, as necessary, shall be at the Contractor's expense and no additional compensation is allowed.

3.02 TEST STRIP

A. The Contractor shall construct a test strip, within the project limits, for evaluation by the Engineer. The test strip shall be a minimum of 750 ft long, shall replicate the full production placement of micro-surfacing, and shall consist of the application courses specified. The test strip shall be constructed at the same time of day or night that the full production of microsurfacing will be placed.

3.03 SAND BLOTTER

A. A sand blotter shall be spread at selected driveways, intersections, and where required by the Engineer to accommodate pedestrian or vehicular traffic until microsurfacing cures. The sand used shall be Lone Star Lupis Luster dried grades #2-16, #1C, #1/20 or an approved equal. Substitutes must be submitted for approval prior to use. Sand blotters at intersections shall be swept within 2 hours of placement, and within 14 hours at other locations.

3.04 JOINTS

A. No excess buildup, uncovered areas, or unsightly appearance shall be permitted on longitudinal or transverse joints. The contractor shall provide suitable-width spreading equipment to produce a minimum number of longitudinal joints throughout the project. When possible, longitudinal joints shall be placed on lane lines. Half passes and odd-width passes will be used only in minimum amounts. If half passes are used, they shall not be the last pass of any paved area. A maximum of three (3) inches (76.2 mm) shall be allowed for overlap of longitudinal lane line joints. Also, the joint shall have no more than a one-fourth (1/4) inch (6.4 mm) difference in elevation when measured by placing a ten (10) foot (3 m) straight edge over the joint and measuring the elevation drop-off. The straight-edge measuring devise shall be provided by the contractor and available for each day of operation. The Engineer will determine areas to be checked in the presence of the contractor. All areas found to be in need of correction, shall be repaired within 48 hours. All work associated with straight-edge checking and repair work, as necessary, shall be at the contractor's expense and no additional compensation is allowed.

3.05 MIX STABILITY

A. Micro-surfacing shall possess sufficient stability so that premature breaking of the material in the spreader box does not occur. The mixture shall be homogeneous during and following mixing and spreading. It shall be free of excess water or emulsion and free of segregation of the emulsion and aggregate fines from the coarser aggregate. Under no circumstances shall water be sprayed directly into the lay-down box while laying micro-surfacing material.

3.06 HANDWORK

A. Areas which cannot be reached with the mixing machine shall be surfaced using hand squeegees to provide complete and uniform coverage. If necessary, the area to be handworked shall be lightly dampened prior to mix placement. Care shall be exercised to leave no unsightly appearance from handwork. The same type of finish as applied by the spreader box shall be required.

3.07 LINES

A. Care shall be taken to ensure straight lines along curbs and shoulders. No runoff on these areas will be permitted. Lines at intersections will be kept straight to provide a good appearance. If necessary, a suitable material will be used to mask off the end of streets to provide straight lines. Edge lines shall not vary by more than ± 2 inches (± 50 mm) horizontal variance in any 96 feet (30 m) of length.

3.08 CLEAN-UP

A. All areas, where micro-surfacing material is placed outside the limits shown on the plans, shall have the micro-surfacing mix removed as specified by the Engineer. The contractor shall, on a daily basis, remove any areas of over-placement and/or debris associated with the performance of the work.

B. If bleeding, raveling, or de-lamination of the new micro-surfacing occurs, the Contractor shall make repairs by any method approved by the Engineer. The Contractor shall not be relieved from maintenance, and final contract payment will not be made, until repairs have been completed. Micro-surfacing shall be removed by a profile grinder and a full lane width pass of micro-surfacing shall be applied in full compliance with this section.

3.09 WEATHER LIMITATIONS

A. Micro-surfacing shall only be placed if both the pavement and air temperatures are at least **50 degrees F and rising**. Do not place micro-surfacing if either the pavement or air temperature is below 50 degrees F and falling. The expected high temperature must be at least 65 degrees F within 24 hours after placement. Do not place micro-surfacing if rain is imminent or the air temperature is expected to be below 36 degrees F within 24 hours after placement.

3.10 TRAFFIC CONTROL

A. All traffic control devices shall be in accordance with State and Federal requirements and, further, shall conform to the requirements in Chapter 6, "Temporary Traffic Control", of the California Manual on Uniform Traffic Control Devices. Suitable methods shall be used by the contractor to protect the Microsurfacing from damage from all types of vehicular traffic. Opening to traffic does not constitute acceptance of the work.

B. Consecutive intersections may not be closed simultaneously.

C. All loose blotter sand is to be removed within 2 hours of placement with a vacuum sweeper.

D. When night work is required, Contractor shall provide the appropriate level of lighting that allows construction work to be completed safely and effectively.

3.11 SURFACE PREPARATION

A. The complete street surface shall be power swept & vacuumed from curb face to curb face prior to application of micro-surfacing. Contractor shall use commercial grade gas-powered rotary brush to remove all dirt and loose material from the pavement. The application of micro-surfacing shall not proceed until the inspector has approved the street sweeping. Vacuum Broom sweepers (Mobile or Equivalent) shall be furnished by the Contractor for this portion of the work. If water is used, cracks shall be allowed to dry thoroughly before applying micro-surfacing. No dry aggregate, either spilled from the lay-down machine or existing on the road, will be permitted to remain.

B. Pavement markings shall be ground-off and pavement markers (permanent and temporary) removed prior to the application of micro-surfacing as per Caltrans Standard Specifications, Section 14-11.12.

C. All materials so gathered shall be properly disposed of off site at the expense of the Contractor. Contractor shall also remove all plant material growing in the street or the interface of the asphalt surface with the lip of concrete gutter prior to placing micro-surfacing, using commercial grade gas-powered rotary brush.

D. Immediately preceding the micro application, the Contractor shall cover all grates, slotted manholes, and other appurtenances on the pavement that would allow the entry of the micro; cover all closed manhole covers, water and gas valve box covers, monuments, monument boxes, etc., with a heavy plastic bag. Locations of manholes, valves and other utility or service entrance shall be recorded both on the plans and on the street curb prior to surfacing. Prior to opening the street to traffic, the Contractor shall uncover all covered grates and manholes within 72 hours after the surfacing application; micro on all other appurtenances shall be broken loose and removed from the street and install centerline rubber floppy markers and stop limit lines.

END OF SECTION

SECTION 02740
WHEEL STOPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for precast concrete wheel stops for vehicular parking stalls in parking structures and parking lots as indicated.

1.02 REFERENCE STANDARDS

A. State of California, Department of Transportation (Caltrans), Standard Specifications:

1. Section 95 Epoxy

1.03 SUBMITTALS

A. Shop Drawings: Submit shop drawings of stops, including installation details and attachment details to at-grade concrete and asphalt pavement, for approval.

B. Product Data: Submit manufacturers' product data of precast stops and epoxy adhesive for approval.

1.04 QUALITY ASSURANCE:

A. Precast wheel stops shall be manufactured for the intended purpose by a company or firm specializing in the manufacture of precast concrete parking appurtenances.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Wheel Stops: Precast, 3.5% minimum air-entrained concrete; 4000 psi minimum compressive strength. Each stop shall be reinforced with two No. 4 deformed steel reinforcing bars, minimum. Provide chamfered corners and drainage slots on underside, and provide holes for dowel-anchoring to substrate. Unless indicated otherwise, provide stops of half octagonal configuration and 36-inch length.

B. Adhesive for Anchoring Stops to Parking Structure Slabs**,** At-Grade Concrete Pavements, and At-Grade Asphalt Pavements: Epoxy adhesive manufactured for the purpose, similar and equal to the adhesives specified in Caltrans Standard Specifications, Section 95-1.02.

C. Adhesive for Bonding Dowel to Wheel Stop: As proposed by Contractor and approved by the Engineer, suitable for application.

D. Steel Bars for Installation: Galvanized 5/8” diameter steel dowels or galvanized No. 5 steel reinforcing bars.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Securely attach wheel stops into at-grade concrete and at-grade asphalt pavement with not less than two galvanized steel dowels embedded in holes cast into wheel stops. Firmly bond each dowel to wheel stop and to pavement.

B. At concrete pavement, drill holes in pavement for dowels.

C. At parking structure slabs, epoxy to slab.

END OF SECTION

SECTION 02780

PAVEMENT STRIPES AND MARKINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for:

1. Traffic stripes and pavement markings for public roadways.

2. Traffic stripes and pavement markings for roadways and parking areas in JPB property, as well as striping and markings for station platforms.

1.02 REFERENCE STANDARDS

A. State of California, Department of Transportation Standard Specifications (Caltrans):

1. Section 84 Markings

B. State of California, Department of Transportation (Caltrans) Standard Plans

1.03 DEFINITIONS

A. The following definition augments definitions in the Caltrans Specifications:

1. Platform safety Warning Striping: Yellow warning stripe applied to the platform where indicated on the Contract Drawings.

1.04 SUBMITTALS

A. Submit manufacturer's product data for materials.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Paint for pavement markings and stripes on JPB roadways, parking areas, and platforms: Paint for traffic stripes as specified in Caltrans Standard Specifications, Section 84-2.02.

B. Thermoplastic for traffic stripes and pavement markings on public roadway: Thermoplastic for traffic stripes as specified in Caltrans Standard Specifications, Section 84-2.02.

PART 3 - EXECUTION

3.01 PREPARATION

A. Layout of Work: Prior to the application of the striping and pavement markings, mark the location of the striping and pavement markings, and request inspection

and obtain Engineer's approval of the layout before proceeding with the application work.

3.02 APPLICATION

A. Apply paint in accordance with Caltrans Standard Specifications, Section 84-2.03.

B. Apply thermoplastic in accordance with Caltrans Standard Specifications, Section 84-2.03.

END OF SECTION

SECTION 02800

STATION FENCE AND RAILING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for furnishing and installation of steel fencing and railing at station platforms, including center fencing, handrailing and platform edge railing.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. A36 Standard Specification for Carbon Structural Steel

2. A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

3. A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

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

5. A787 Standard Specification for Electric-Resistance-Welded Metallic-Coated Carbon Steel Mechanical Tubing

1.03 SUBMITTALS

A. Submit shop drawings showing plan layout, grid, spacing of components, accessories, fittings, and hardware.

B. Submit manufacturer's product data.

C. Submit manufacturer's installation instructions.

D. Submit manufacturer's color palette to the Engineer for approval.

1.04 DELIVERABLES

A. Submit manufacturer's certificates of compliance for fence materials.

B. Qualifications: Submit name, business address and telephone number of fabricator's field representative.

C. Furnish certificate of inspection stating that the material has been sampled, tested and inspected per ASTM A653.

1.05 QUALITY ASSURANCE

A. Obtain the services of fencing fabricator's field representative to provide advice and assistance on the installation of the fence panels, fasteners, and repair work.

1.06 EXTRA MATERIALS

A. Furnish the following extra materials for center fence, and for platform edge railing as follows. Securely fasten the panels and posts on wooden pallets, and the hardware in plastic container clearly marked "Station Fencing/Railing," and deliver them to the Engineer's warehouse located within 25 miles of the project site.

1. For station center fence: 2 panels including 2 posts, and all necessary hardware.

2. For station platform edge railing: 4 panels including 4 posts, and all necessary hardware.

PART 2 - PRODUCTS

2.01 FENCE AND GATES

A. Fence panel width, other dimensions, and details including spacing of pickets, rings, posts, details of post caps, fasteners, etc.: see Caltrain Standard Drawings unless shown otherwise in Contract Drawings.

1. Finished center fence height shall be 6 feet from top of rail of higher adjacent tracks.

B. Posts, rails, and hardware:

1. Posts and post caps: Galvanized, square steel tubular members conforming to ASTM A787 and G90 zinc coating.

2. Horizontal rails: Galvanized, square steel tubular members conforming to ASTM A787, 50,000 psi yield strength and G90 zinc coating. Attach rails to posts with tamper resistant fasteners.

3. Hardware (Base Plates, Anchor Bolts, Gate Hardware and Miscellaneous Hardware): ASTM A36.

4. Nuts and Washers: Nuts and washers shall conform to Caltrans Standard Specifications, Section 55-1.02D, Materials.

5. Epoxy Grout: Epoxy grout shall conform to Section 03150, Concrete Accessories.

C. Gate Hardware: Hinges, latches, drop rods, as needed, shall be hot dip galvanized steel in accordance with ASTM A153 and sized to assure proper gate operation.

2.02 CONCRETE

A. Concrete: Concrete shall conform to the following:

1. Portland Cement: ASTM C-150, type 2 or 5 (Low alkali)

2. Aggregates:

a. Coarse aggregates: crushed rock, max 1-1/2 inch, #200: 2% maximum

b. Sand: 3/8 inch maximum, #200: 2% maximum

3. Compressive strength (minimum): 2,500 psi @7 days, 4,000 psi @ 28 days

4. Slumps: 2 to 4.5 inches

B. Footing hole shall be clear of roots or other organic materials. Moist hole prior to concrete pour. No water standing at bottom of hole.

C. Consolidate concrete to remove air pockets.

2.03 SHOP FINISHES

A. Galvanizing: Hot dip galvanize fence panels, rails and all associated hardware after fabrication in accordance with ASTM A123. Coating Thickness: Minimum 90 microns, and,

B. Powder Coat: Powder coat all parts of fence including hardware after galvanizing and in accordance with coating manufacturer's instructions. Powder coat: O'Brien TGIC-Polyster or Engineer approved equal. Color: Black.

PART 3 – INSTALLATION

3.01 INSTALLATION

A. Concrete Footings: Drill or dig holes for post footings in firm, undisturbed or compacted soil or ballast. Towel top of footings, and slope or dome to direct water away from posts. For railing on station platform, flush the epoxy with the platform.

B. Field Joints: Field joints shall be kept to a minimum and concealed to the greatest extent possible. Field joints shall be strong, rigid, watertight and flush with hairline fit. Ease sharp corners.

C. Adjust fence for uninterrupted visual continuity and tight, non-rattling connections.

D. For station center fence: Restore ballast to flush with the top of ties.

3.02 REPAIR

A. Welded and abraded areas of galvanized surfaces shall be wire brushed and repaired with 2 coats of cold galvanized compound.

B. Repair abraded or damaged powder-coated per manufacturer's instructions.

END OF SECTION

SECTION 02810
CHAIN LINK FENCE

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for furnishing and installation of chain link fence and gates (personal, and swing or sliding gates).

B. Install fence with polymer-coated finish (over hot-dip galvanizing) at locations as indicated on the Contract Drawings, such as where the fence is adjacent to bike path.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

2. A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

3. A392 Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric

4. A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

5. F522 Standard Terminology Relating to Chain-Link Fencing

6. F567 Standard Practice for Installation of Chain-Link Fence

7. F626 Standard Specification for Fence Fittings

8. F668 Standard Specification for Polyvinyl Chloride (PVC), Polyolefin and Other Polymer-Coated Steel Chain-Link Fence Fabric

9. F900 Standard Specification for Industrial and Commercial Steel Swing Gates

10. F934 Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials

11. F1043 Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework

12. F1083 Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

B. Federal Specification:

1. RR-F-191/2C Fencing, Wire and Post, Metal (Chain Link Fence Gates) (Detail Specification)

1.03 SUBMITTALS

A. Submit shop drawings for fencing and gates.

B. Manufacturer's technical data and installation instructions for fencing and gates.

C. Samples: For the polymer-coating, submit manufacturer's color chart of available colors and physical sample of color.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Fabric: Hot-dip galvanizing conforming to ASTM A123 and A153 as applicable.

1. Mesh Size and Gauge: 2 inches, 8 gauge wire

2. Top and bottom salvages twisted and barbed

3. Tension wire (top and bottom edges): coil spring wire, 7 gauge

4. Use one piece fabric widths

B. If polymer-coated finish is required, Polymer-coated (over galvanizing) conforming to ASTM F668, Class 1, 2, or 2b, and ASTM F1043. Wire gage specified for polymer coated fabric shall be the steel core wire, not the finish coated diameter. Color: Black in accordance with ASTM F934, unless otherwise indicated.

1. Fuse and adhere a minimum 10-mil (0.254 mm) PVC coating or polyolefin coating to the zinc exterior coating of the framework.

2. Polymer coated gate frames and gateposts: Match the coating type and color specified for the fence framework. Moveable parts such as hinges, latches and drop rods may be field coated in lieu of factory coated. Field Coating: Liquid polymer field touch up coating.

C. Round Steel Pipe and Rail: Schedule 40 ASTM F1083, Group 1A, Regular Grade, 1.8 oz/sq ft hot-dipped galvanized zinc exterior and interior per ASTM A123.

D. Miscellaneous Hardware, Fittings and Appurtenances: Manufacture to industry standards, commercial quality, and suitable for the purpose used.

E. Terminal Posts, Rails, Brace assembly: see Caltrain Standard Drawings for details and dimensions unless shown otherwise in Contract Drawings.

F. Post Caps: Cast or malleable iron ball or acorn shape. Caps shall have opening for through rail where top rails are indicated.

G. Wire Ties shall be as follows:

1. For tying fabric to tension wires: 11 gauge hog rings spaced 24 inches on center

2. For tying fabric to line posts: 9 gauge wire spaced 12 inches on center

3. For tying fabric to rails and braces: 9 gauge wire spaced 24 inches on center.

H. Bands: Use 14 gauge by 1 inch wide steel bands spaced 15 inches on center for securing stretcher bars to end, corner, pull and gate posts. Bands may be used in conjunction with special fittings for securing rails to end, corner and pull posts. Chamfer or ease projecting edges of bands.

I. Sleeves for Anchoring Railing Posts in Concrete: Galvanized standard pipe sleeves with welded on bottom plates, or 24 gage galvanized sheet metal sleeves with bottoms.

J. Galvanizing: Hot dip galvanize ferrous materials after fabrication per ASTM A123 or A153 as applicable. Repair zinc coating damaged in shop or during field erection by recoating with hot repair compound, applied per manufacturer's recommendations.

K. Hot Repair Compound: Re Galv, Galvalloy, Galvweld alloy, or Engineer approved equal.

L. Non-Shrink Grout (if used): Master Builders "Embeco", Sonneborn Building Products, Inc. "Ferrolith G", Halemite Manufacturing Company "Pro Rok", or Engineer approved equal.

M. Gates shall be swing type or sliding type as indicated in the Contract Drawings, furnished complete with all hardware and accessories as required for a complete installation.

1. Gate Frames: Frames shall be fabricated with materials as specified for fence framework and fabric.

2. Fabrication: Conform to applicable requirements of ASTM F900, Federal Specification RR-F-191/C, and the following:

a. Assemble gate frames by welding or with fittings and rivets for rigid connections. Attach hardware with rivets or by other means that will provide security against removal or breakage.

b. Provide additional horizontal members, vertical members, and diagonal cross bracing to ensure proper gate operation, frame rigidity without sag or twist, and for attachment of fabric, hardware, and accessories.

3. Gate Hardware:

a. Swinging Gates: Provide gate hinges, latch, stop, and keeper for each gate leaf, conforming to applicable requirements of ASTM F900 and Federal Specification RR-F-191/2C. Provide latch with provision for locking gate with a padlock.

b. Sliding Gates: Provide manufacturer's standard rubber-tired rollers and roller track for floor-supported sliding gates. Include intermediate rollers or casters where required to prevent gate sag or deflection. Provide locking device and padlock eyes as part of latch for locking gate with a padlock.

2.02 CONCRETE

A. Concrete: Concrete shall conform to the following:

1. Portland Cement: ASTM C-150, type 2 or 5 (Low alkali)

2. Aggregates:

a. Coarse aggregates: crushed rock, max 1-1/2 inch, #200: 2% maximum

b. Sand: 3/8 inch maximum, #200: 2% maximum

3. Compressive strength (minimum): 2,500 psi @7 days, 4,000 psi @ 28 days

4. Slumps: 2 to 4.5 inches

B. Footing hole shall be clear of roots or other organic materials. Moist hole prior to concrete pour. No water standing at bottom of hole.

C. Consolidate concrete and remove air pockets.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Alignment and Grade: Verify horizontal alignment and grades as established by survey and plan dimensions and elevations. Securely set posts in alignment at proper depth and height, and rigid bracing where needed.

B. Concrete Footings: Drill or dig holes for post footings in firm, undisturbed or compacted soil. Depth and post embedment as indicated in the Caltrain Standard Drawing. Trowel tops of footings and slope or dome to direct water away from posts. Slope, do not dome, in pedestrian paving.

C. Setting Posts:

1. Set in concrete footings, plumbed vertical. Post depth and spacing as indicated on the Standard Drawings unless shown otherwise in Contract Drawings. Space posts at lesser distance between centers to compensate for terrain variation such as sharp variations in incline or decline.

2. Grout posts in concrete walls and curbs in sleeved holes with non-shrink grout. If built in without sleeves, set posts in vertical and top edge alignment, hold in place until concrete has set.

D. Fit posts with post caps, line post caps, or barbed wire extension arms, as applicable. Snugly fit fittings over posts and exclude moisture.

E. Top Rail: Pass top rails through the line post caps and form a continuous brace from end to end of each stretch of fence. Join top rail lengths with sleeves. Securely fasten top rail to terminal posts by means of rail ends and brace bands. Provide expansion couplers as recommended by the fence manufacturer.

F. Horizontal Braces and Truss Rods: Securely fasten brace to the line post and terminal post by rail ends and brace bands. Install a truss rod, including tightening device, from the end of the brace on the line post to the terminal post just above the bottom of fence fabric using brace bands.

G. Diagonal Braces: Install the diagonal brace with rail ends and brace bands. Fasten the brace at the locations described for a truss rod.

H. Tension Wire: Stretch tension wire out between terminal posts and secure at the terminal posts by means of tension bands.

I. Fence Fabric: Pull fabric taut and tie to posts, rails and tension wires. Fabric shall remain under tension after pulling force is released.

J. Tie Wires: Use U-shaped wires, same diameter as pipe to which attached, clasping pipe and fabric firmly with ends twisted two full turns minimum. Bend ends of wires to prevent hazard to persons or apparel.

K. Fasteners: Install nuts for tension band and hardware bolts on side of fence opposite fabric side. Peen ends of bolts to prevent removal of nuts.

L. Gates shall be installed plumb, level, and secure for full opening without interference. Install ground-set items in concrete as recommended by the fence manufacturer. Adjust hardware for smooth operation and lubricate. Sliding gates shall operate smoothly and easily under minimum pressure.

3.02 REPAIR

A. Repair abraded or damaged galvanized surfaces with hot process field galvanizing in accordance with ASTM A780 and manufacturer's published instructions.

B. For polymer-coated panels, prepare and recoat damaged PVC coatings, including where component has been cut, in accordance with manufacturer's instructions.

END OF SECTION

SECTION 02820

EXPANDED METAL MESH FENCE

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for expanded metal mesh fence and gates (personal, and sliding or swing gates), and furnishing extra materials.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. A36 Standard Specification for Carbon Structural Steel

2. A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

3. A1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

4. F626 Standard Specification for Fence Fittings

5. F1083 Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

6. F1267 Standard Specification for Metal, Expanded, Steel

1.03 SUBMITTALS

A. Submit shop drawings showing plan layout, grid, spacing of components, accessories, fittings and hardware.

B. Submit manufacturer's product data.

C. Submit manufacturer's installation instructions.

1.04 DELIVERABLES

A. Submit manufacturer's certificates of compliance for fence materials.

B. Qualifications: Submit name, business address and telephone number of manufacturer's field representative. Include certification by the manufacturer that proposed field representative is qualified to provide specified services.

C. Certification of Installation: Subject affidavit by the manufacturer's field representative certifying that the installation of the expanded metal mesh fence meets the Contract requirements.

1.05 QUALITY ASSURANCE

A. Obtain the services of fencing manufacturer's field representative to provide the following services:

1. Supervise the entire installation of the fence

2. Render advice and assistance on the installation of the fence panels, posts, and fasteners

1.06 EXTRA MATERIALS

A. Extra materials shall match that installed in the Work. Furnish the following extra materials for every 1,000 linear feet (or fraction thereof) of each separate height and type of fence:

1. Two panels, with required number of fittings for installation, including 2 line posts fitted with caps.

2. Fittings (in addition to fittings furnished with extra panels): 20 - 2-1/2 inches clamps; 20 - 1 5/8 inch clamps; 20 – 2-1/2 inches line rail clamps; 20 back straps.

PART 2 - PRODUCTS

2.01 RIGHT-OF-WAY FENCE

A. Secura Expanded Mesh Fence System as manufactured by Alabama Metal Industries Corporation (AMICO), or Engineer approved equal.

B. Fabric: Type I (expanded), Class 2 (hot-dip galvanized), Grade A (0.06 mm minimum coating thickness) Carbon HSLA steel conforming to ASTM A1011. Sheet steel slit and stretched into a rigid, open mesh diamond shape openings.

1. Maximum carbon content of 0.15 percent

2. Tensile strength shall be at least 40,000 psi with typical yield point of 38,000 psi

3. Mesh Strand (nominal minimum): 0.1 inch (width and thick)

4. Short way of diamond run horizontally.

C. Terminal Posts: Posts shall comply with ASTM F1083, and the following:

1. Mesh configuration, terminal posts, bracing, railings, etc.: see Caltrain Standard Drawing or Contract Drawing for details and dimensions.

2. Terminal Posts (end, corner, gate, line posts): 4 inch nominal diameter, schedule 40 pipe. Each cap shall have a cap to seal out moisture.

3. Post Cap: Pressed steel dome cap

4. Base Plates and Miscellaneous Hardware: ASTM A36

D. Horizontal Rails: Rails shall comply with ASTM F1083. All rails shall be cut between and securely fastened to the posts using the proper sized 11 gage line rail clamps.

E. Fasteners and Fittings: Manufacturer fittings, and all hot-dip galvanized.

1. Fittings: "No Access Fittings", heavy pressed steel construction conforming to ASTM F626

2. Bands: Secura Bands: 11 gauge by 1 inch steel with 3 inch neck and slotted hole

3. Clamps: Secura Clamps: 11 gauge by 1 inch steel with 2 slotted holes

4. Back Straps: Secura Back Straps: 11 gauge by 1 inch steel with 2 slotted holes

5. Bolts: Carriage bolts 3/8 inch by 2 inch to secure fittings. Tighten securely and peen or scarf threads to prevent removal.

F. Gate Hardware: Hinges, latches, drop rods, as needed, shall be hot dip galvanized steel and sized to assure proper gate operation. Finish to match the fabric.

2.02 CONCRETE

A. Concrete: Concrete shall conform to the following:

1. Portland Cement: ASTM C-150, type 2 or 5 (Low alkali)

2 Aggregates:

a. Coarse aggregates: crushed rock, max 1-1/2 inch, #200: 2% maximum

b. Sand: 3/8 inch maximum, #200: 2% maximum

3. Compressive strength (minimum): 2,500 psi @7 days, 4,000 psi @ 28 days

4. Slumps: 2 to 4.5 inches

B. Footing hole shall be clear of roots or other organic materials. Moist hole prior to concrete pour. No water standing at bottom of hole.

C. Consolidate concrete and remove air pockets.

2.03 SHOP FINISHES

A. Zinc: Hot dip galvanized posts and expanded metal mesh after fabrication in accordance with ASTM A123.

PART 3 - INSTALLATION

3.01 INSTALLATION

A. Alignment and Grade: Verify horizontal alignment and grades as established by survey and plan dimensions and elevations. Securely set posts in alignment at proper depth and height, and rigid bracing where needed.

B. Concrete Footings: Drill or dig holes for post footings in firm, undisturbed or compacted soil. Depth and post embedment as indicated in the Caltrain Standard Drawing. Trowel tops of footings and slope or dome to direct water away from posts. Slope do not dome, in pedestrian paving.

C. Posts: Set in concrete footings, plumbed vertical. Post depth and spacing as indicated on the Standard Drawing or Contract Drawing. Space posts at lesser distance between centers to compensate for terrain variation such as sharp variations in incline or decline.

D. Fabric Panel to Post Attachment:

1. Attach panels to posts with bands sized to fit posts and spaced per manufacturer's recommendation.

2. To each terminal post, lap fence fabric over one half the width of the post to prevent any open space between the post and the fabric.

3. To each line post with the cant side of the fence fabric oriented in the same the same direction. Overlap fabric panels a minimum of three diamonds. Secure fabric panel to line posts using a minimum of seven (7) clamps, evenly spaced, per post with one above the top rail and one below the bottom rail.

4. Panels shall be placed within 2 inches of ground. High points which interfere with the placing of mesh panels shall be excavated to provide the clearance indicated on the Contract Drawings.

E. Fence Fabric: Pull fabric taut and tie to posts, rails and tension wires. Fabric shall remain under tension after pulling force is released.

F. Fabric to Horizontal Rail Attachment: Use a minimum of six (6) clamps per rail per panel. Evenly space clamps between posts.

G. Panel to Panel Attachment: Overlap fabric a minimum of 6 inches (three diamonds). Fasten using a minimum of six (6) back straps, evenly space, with one above the top rail and one below the top rail.

H. Gates shall be installed plumb, level, and secure for full opening without interference. Install ground-set items in concrete as recommended by the fence manufacturer. Adjust hardware for smooth operation and lubricate. Sliding gates shall operate smoothly and easily under minimum pressure.

3.02 REPAIR

A. Repair abraded or damaged galvanized surfaces with hot process field galvanizing in accordance with ASTM A780 and manufacturer's published instructions.

END OF SECTION

SECTION 02830
WELDED WIRE MESH FENCE

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for furnishing and installation of welded wire mesh fence and gates (personal, and swing or sliding gates), and furnishing extra materials.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. A36 Standard Specification for Carbon Structural Steel
2. A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
3. A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
4. A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
5. F626 Standard Specification for Fence Fittings
6. F1083 Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
7. D2201 Standard Practice for Preparation of Zinc-Coated and Zinc-Alloy-Coated Steel Panels for Testing Paint and Related Coating Products

1.03 SUBMITTALS

A. Submit shop drawings showing plan layout, grid, spacing of components, accessories, fittings and hardware.

B. Submit manufacturer’s product data.

C. Submit manufacturer’s installation instructions.

D. Submit manufacturer’s color palette to the Engineer for approval.

1.04 DELIVERABLES

A. Submit manufacturer’s certificates of compliance for fence materials.

B. Qualifications: Submit name, business address and telephone number of manufacturer's field representative. Include certification by the manufacturer that proposed field representative is qualified to provide specified services.

C. Certification of Installation: Subject affidavit by the manufacturer's field representative certifying that the installation of the welded wire mesh fence meets the Contract requirements.

1.05 QUALITY ASSURANCE

A. Obtain the services of fencing manufacturer's field representative to provide the following services:

1. Supervise the entire installation of the welded wire mesh fence.

2. Render advice and assistance on the installation of the welded wire mesh fence panels, fasteners and bracing; clip installation and fastening to post; and on tensioning of panels.

1.06 EXTRA MATERIALS

A. Extra materials shall match that installed in the Work. Furnish the following extra materials for every 1,000 linear feet (or fraction thereof) of each separate height and type of fence.

1. Two panels, including 2 line posts, including caps

2. Fittings (in addition to fittings furnished with extra panels): 20 each hat brackets; 20 each gouge ties; 20 each fasteners.

B. The panels shall be rolled and tightened with the posts; all hardware shall be in plastic or steel container(s) clearly marked "Fence and year of project". Deliver these materials to the Engineer's warehouse within 25 miles from project site.

PART 2 - PRODUCTS

2.01 RIGHT-OF-WAY FENCE

A. Typhoon style welded wire mesh fence system as manufactured by Secure Technology, or by CE Shepard, or Engineer approved equal.

B. Mesh configuration, terminal posts, bracing, railings, etc.: see Caltrain Standard Drawing or Contract Drawing.

C. Wire: Hardened elongated, 7 gage, stretched diameter.

1. The material breaking point of the welded mesh shall be at least 62,000 psi

2. The tensile strength of the wire mesh shall be at least 71,000 psi

3. The elongation factor of the wire mesh shall be 7 percent

4. Welding points shall be able to withstand force of at least 1200 lbs

D. Terminal Posts:

1. The square steel tubing can be substituted with schedule 40 steel pipe only if the fence manufacturer has confirmed in writing that the tubular member is compatible to installation of the mesh fence panels.

2. Post Caps: Each post shall have a square cap to seal out moisture. Flat and form plastic to the shape of the post. Coating to match the fabric.

3. Base Plates and Miscellaneous Hardware: ASTM A36.

E. Bottom Rails and Bracing:

1. The rectangular steel tubing can be substituted with schedule 40 steel pipe only if the fence manufacturer has confirmed in writing that the tubular member is compatible to installation of the mesh fence panels.

F. Fence hardware: Manufacturer fittings, and all hot-dip galvanized.

1. Fasteners Connecting Panels to Each Post: 3 mm diameter "U" shaped wire fastener.

2. Hat brackets (horizontal connectors of the welded wire mesh fence): 0.05-inch thick by 1.18 inches long pre-molded clip fastener.

3. Gouge ties (vertical connectors of the welded wire mesh fence): 0.05-inch thick by 0.59 inches long pre-molded clip fastener.

G. Gate Hardware: Hinges, latches, drop rods, as needed, shall be hot dip galvanized steel and sized to assure proper gate operation. Finish to match the fabric.

2.02 CONCRETE

A. Alignment and Grade: Verify horizontal alignment and grades as established by survey and plan dimensions and elevations. Securely set posts in alignment at proper depth and height, and rigid bracing where needed.

B. Concrete: Concrete shall conform to the following:

1. Portland Cement: ASTM C-150, type 2 or 5 (Low alkali)

2. Aggregates:

a. Coarse aggregates: Crushed rock, max 1-1/2 inch, #200: 2% maximum

b. Sand: 3/8 inch maximum, #200: 2% maximum

3. Compressive strength (minimum): 2,500 psi @7 days, 4,000 psi @ 28 days

4. Slumps: 2 to 4.5 inches

C. Footing hole shall be clear of roots or other organic materials. Moist hole prior to concrete pour. No water standing at bottom of hole.

D. Consolidate concrete and remove air pockets.

2.03 SHOP FINISHES

A. Zinc: Hot dip galvanized posts and welded wire mesh after fabrication in accordance with ASTM A123.

PART 3 - INSTALLATION

3.01 INSTALLATION

A. Concrete Footings: Drill or dig holes for post footings in firm, undisturbed or compacted soil. Depth and post embedment as indicated in the Caltrain Standard Drawing. Trowel tops of footings and slope or dome to direct water away from posts. Slope, do not dome, in pedestrian paving.

B. Posts: Set in concrete footings, plumbed vertical. Post depth and spacing as indicated on the Standard Drawing or Contract Drawing. Space posts at lesser distance between centers to compensate for terrain variation such as sharp variations in incline or decline.

C. Install welded mesh panels according to manufacturer's instructions and generally as follows:

1. Begin at corner/start post. Layout each piece of the welded wire mesh fence. Connect mesh panels with a minimum of 8 junction clips per panel.

2. Connect one end of tensioning device to the intermediate post that is fastened to support brace. Connect other end of tensioning device to the connected panels. Tension mesh panels with 2000 lb. pull in tensioning device. Leave tensioning device connected until the adjacent section is installed and tensioned. Repeat this operation until the welded mesh fence is installed from corner post to corner post.

3. Trim panels as needed for landscaped purposes.

D. Fence Fabric: Pull fabric taut and tie to posts, rails and tension wires. Fabric shall remain under tension after pulling force is released.

E. Gates shall be installed plumb, level, and secure for full opening without interference. Install ground-set items in concrete as recommended by the fence manufacturer. Adjust hardware for smooth operation and lubricate. Sliding gates shall operate smoothly and easily under minimum pressure.

3.02 REPAIR

A. Repair abraded or damaged galvanized surfaces with hot process field galvanizing in accordance with ASTM A780 and manufacturer's published instructions.

END OF SECTION

SECTION 02840
CABLE RAILING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for furnishing and installation of exterior cable railing on bridges, structures, or embankments as indicated on the Contract Drawings.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

2. A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

3. A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

B. Federal Specification:

1. RR-W-410H Wire Rope and Strand

1.03 SUBMITTALS

A. Submit shop drawings for railing posts and cables.

1. Sizes, details of fabrication and construction, methods of assembly, locations of hardware, anchors, and accessories, and installation details.

2. Details for manufacturer’s items or fabricated metalwork.

3. Field erection details showing cuts, copes, connections, holes, threaded fasteners and welds, both shop and field, by symbols conforming to AWS standards. Indicate net weld lengths.

B. Manufacturer's technical data and installation instructions for railing posts and cables Include application instructions for galvanizing repair product.

1.04 DELIVERABLES

A. Welders' Certificates: Submit certification of personnel employed on the work to satisfy the requirements of Clause 4 of AWS D1.1.

1.05 QUALITY ASSURANCE

A. Welding including shielded arc process shall conform to the requirements in AWS

D1.1 Structural Welding Code.

B. All components in this Section shall be fabricated in shop for desired quality. Use only well experienced welders and fitters.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Pipe for posts and braces shall be hot-dipped galvanized ASTM A500 grade B, ASTM A501 grade A or better. Steel plate and other miscellaneous steel shall comply with Section 05100, Metal Fabrications.

B. Galvanize posts and braces in accordance with Section 05100, Metal Fabrications.

C. Truss rods, post tops, cable clamps, eye bolts, thimbles, and other required fittings must be commercial quality steel, malleable iron, or wrought iron. Post tops must be watertight. The eye of the eye bolts must be either drop forged or formed with a complete penetration weld. The eye must develop 100 percent of the bolt strength.

D. Turnbuckles shall be steel pipe type or drop-forged steel, hot-dipped galvanized, and have jaw or eye ends. Turnbuckles shall have 2,700 pounds minimum breaking strength and be secured in place with thread lock once installed and tensioned.

E. Crimped sleeve clamps and stop sleeve clamps shall be hot-dipped galvanized steel, shall develop the strength of the cable, and shall be the color of the cable.

F. Cable shall be wire strand or rope with a minimum diameter of 5/16 inch, and a minimum breaking strength of at least 1,800 pounds. Cable shall be hot-dipped galvanized steel in conformance with RR-W-410H.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Alignment and Grade: Verify horizontal alignment and grades as established by survey and plan dimensions and elevations. Securely set posts in alignment at proper depth and height, and rigid bracing where needed.

B. Setting Posts:

1. Set in concrete footings as applicable, plumbed vertical. Post depth and spacing as indicated on the approved shop drawings.

2. Grout posts in concrete walls and curbs in sleeved holes with non-shrink grout as applicable.

C. Fit posts with post caps, or line post caps, as applicable. Snugly fit fittings over posts and exclude moisture.

D. Install the diagonal brace with brace bands.

E. Install and tension cables to provide taut railings between posts. Tension cables by hanging a 10 pound weight on the cable between two posts and remove all sag to a maximum of 2 inches.

F. Provide a tamper-resistant connection between the cables and turnbuckles.

3.02 REPAIR

A. Repair abraded or damaged galvanized surfaces with hot process field galvanizing in accordance with ASTM A780 and manufacturer's published instructions.

END OF SECTION

SECTION 02900

PLANTING

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes requirements for landscaping, including furnishing and installing topsoil, soil amendments, mulch, trees, shrubs, groundcovers, tree staking, and header boards.

1.02 REFERENCE STANDARDS

A. American National Standards Institute (ANSI):

1. Z60.1 American Standard for Nursery Stock

B. ASTM International (ASTM):

1. A641 Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire

2. D5268 Standard Specification for Topsoil Used for Landscaping and Construction Purposes

1.03 DEFINITIONS

A. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than sizes indicated. Stock shall be wrapped, tied, rigidly supported, and drum-laced conforming to the requirements in ANSI Z60.1.

B. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for kind, type, and size of exterior plant required.

C. Finish Grade: Elevation of finished surface of planting soil.

D. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

E. Subgrade: Surface or elevation of subsoil remaining after completing excavation or top surface of a fill or backfill before placing planting soil.

1.04 SUBMITTALS

A. Submit product data for each type of product.

B. Samples for verification for each of the following:

1. One pound of bark mulch in labeled plastic bags

C. Submit certificates of compliance for each type of manufactured product, signed by product manufacturer, certifying the following:

1. Manufacturer's certified analysis for standard products

2. Analysis of other materials by a recognized laboratory conforming to methods established by the Association of Official Analytical Chemists, where applicable.

D. Material test reports for existing surface soil, imported topsoil, and soil amendments. Include laboratory reports for topsoil including analysis and recommendation.

E. Qualification data for landscape installer and soil-testing laboratory.

F. Maintenance instructions listing recommended procedures to be established by the Owner for maintenance of exterior plants during a calendar year; submit before expiration of required maintenance periods.

1.05 DELIVERABLES

A. Planting schedule indicating anticipated planting dates for exterior plants. Coordinate planting schedule with Progress Schedule.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of exterior plants. Installer shall possess a State of California Landscape Contractor's license and meet the State of California Licensing Requirements for the application of herbicides.

B. Installer's Field Supervision: Installer shall maintain an experienced full-time supervisor on site when exterior planting is in progress.

C. Soil-Testing Laboratory Qualifications: An independent laboratory recognized by the State Department of Agriculture with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

D. Pre-Installation Conference: Conduct pre-installation conference at project site. Schedule conference in coordination with the Engineer. Attendees shall include Contractor, planting installer, landscape irrigation installer, and the Engineer.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver exterior plants freshly dug.

B. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to

destroy their natural shape. Provide protective covering of exterior plants during delivery. Do not drop exterior plants during delivery.

C. Handle planting stock by root ball.

D. Deliver exterior plants after preparations for planting have been completed and install immediately. If planting is delayed more than 6 hours after delivery, set exterior plants and trees in shade, protect from weather and mechanical damage, and keep roots moist.

1. Do not remove container-grown stock from containers before time of planting.

2. Water root systems of exterior plants stored on-site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

E. Store fertilizers and soil amendments in a dry place and protect from intrusion of moisture.

1.08 COORDINATION

A. Coordinate installation of planting materials during normal planting seasons for each type of plant material required.

B. Proceed with planting only when existing and forecasted weather conditions permit.

1.09 WARRANTY

A. Refer to General Provisions GC4.3, Guaranty of Work. The Guaranty of Work shall include the following provisions in regard to planting including plant materials.

1. Warrant against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by Owner, or incidents that are beyond the Contractor's control.

2. Remove dead exterior plants immediately, and replace immediately unless required to plant in the succeeding planting season.

3. Replace exterior plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.

4. A limit of one replacement of each exterior plant will be required, except when losses or replacements are due to failure to comply with requirements.

1.10 MAINTENANCE

A. Maintenance Period: 12 months from date of Substantial Completion.

B. Trees and Shrubs: Perform maintenance throughout the maintenance period including pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, tightening and repairing stakes and guy supports, and resetting to proper grades and vertical position as required to establish healthy, viable plantings. Spray as required to keep trees and shrubs free of insects and disease. Restore or replace damaged tree wrappings.

C. Ground Cover and Plants: Perform maintenance throughout the maintenance period including watering, weeding, fertilizing, and other operations as required to establish healthy, viable plantings:

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide quality, size, genus, species and variety of exterior plants indicated conforming to the requirements in ANSI Z60.1.

B. Selection of exterior plants shall be made in conjunction with the Engineer, who will witness tagging plants at their place of growth before they are prepared for transplanting.

C. Measure trees and shrubs according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches above ground for trees up to 4-inch caliper size, and 12 inches above ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.

D. The Engineer may observe trees and shrubs either at place of growth or at site before planting for compliance with requirements for genus, species, variety, size, and quality. The Engineer retains the right to observe trees and shrubs further for size and condition of balls and root systems, insects, injuries and latent defects, and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from the project site.

1. Notify the Engineer of sources of planting materials 7 days in advance of delivery to site.

2. Make no plant substitutions.

2.02 TREE AND SHRUB MATERIAL

A. Furnish nursery-grown trees and shrubs conforming to the requirements in ANSI Z60.1 with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots,
sun scald, injuries, abrasions, and disfigurement.

B. Provide trees and shrubs of sizes and grades conforming to the requirements in ANSI Z60.1 for type of trees and shrubs required. Trees and shrubs of a larger size may be used if acceptable to the Engineer with a proportionate increase in size of roots or balls.

C. Label each tree and shrub with securely attached, waterproof tag bearing legible designation of botanical and common name.

D. If formal arrangements or consecutive order of trees or shrubs is shown, select stock for uniform height and spread, and number label to assure symmetry in planting.

2.03 SHADE AND FLOWERING TREES

A. Shade Trees: Single-stem trees with straight trunk, well-balanced crown and intact leader, of size indicated, conforming to the requirements in ANSI Z60.1 for type of trees required.

1. Branching height shall be 1/3 to 1/2 of tree height

2. Provide container-grown trees

B. Small Upright or Spreading Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height and branching conforming to the requirements in ANSI Z60.1.

1. Stem form shall be multi-stem, clump, with 2 or more main stems

2. Provide container-grown trees

2.04 GROUND COVERS

A. Provide ground cover of species indicated, established and well-rooted in pots or similar containers, conforming to the requirements in ANSI Z60.1.

2.05 TOPSOIL

A. Topsoil shall conform to the requirements in ASTM D5268, pH range of 6.0 to 6.8, fertile, friable, natural topsoil of sandy loam character, without admixture of sub-soil material, obtained from a well-drained arable site, reasonably free from clay, lumps, coarse sands, stones, plants, roots, sticks and other foreign materials.

1. Identify source location of topsoil proposed for use in the Work.

2. Provide topsoil free of substances harmful to the plants which will be grown in the soil.

B. Furnish topsoil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of topsoil.

1. Include suitability of topsoil for plant growth. State recommended quantities of nitrogen, phosphorus, potash nutrients and soil amendments to be added to produce satisfactory topsoil.

2.06 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through one-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and the following:

1. Organic Matter Content: 50 to 60 percent of dry weight

2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste

B. Peat: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 to 4.8.

C. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste of uniform texture, free of chips, stones, sticks, soil or toxic materials.

1. In lieu of decomposed wood derivatives, mix partially decomposed wood derivatives with at least 0.15 lbs of ammonium nitrate or 0.25 lbs of ammonium sulfate per cubic foot of loose sawdust or ground bark.

D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed and material harmful to plant growth.

2.07 FERTILIZER

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous and potassium in the following composition:

1. Nitrogen, phosphorous and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus and potassium in the following composition:

1. Nitrogen, phosphorous and potassium in amounts recommended in topsoil analysis.

2.08 PLANTING SOIL

A. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

2.09 MULCHES

A. Organic mulch shall be free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Medium fir bark or wood chips

2. Rock mulch: As specified in the Contract Documents

2.10 STAKES

A. Metal Stakes for 15 gallon can and 24 inch box trees: Schedule 40 steel, 9-foot length, 3/4 inch diameter, with screw in auger-type tip, adjustable height 'T'-bar, UV-resistant vinyl tubing, 3 cable ties, anti-rotational tab and pin, powder coated black. As available from Decorations for Generations, Inc. Guy and Tie Wire: Conform to ASTM A641, Class 1, galvanized-steel wire, 2-strand, twisted, 0.106-inch in diameter.

2.11 MISCELLANEOUS PRODUCTS

A. Anti-desiccant: Water-insoluble emulsion, permeable moisture retarder, film forming for trees and shrubs. Deliver in original, sealed and fully labeled containers and mix according to manufacturer's written instructions.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to receive exterior plants for compliance with requirements and conditions affecting installation and performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Protect structures, utilities, sidewalks, pavements and other facilities, and lawns and existing exterior plants from damage caused by planting operations.

B. Refer to Section 01560, Temporary Controls, for requirements to prevent erosion, displacement of soils, discharge of soil-bearing water runoff, and airborne dust.

C. Lay out individual tree and shrub locations, and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain acceptance of the layout by the Engineer before planting. Make adjustments as required.

D. Apply anti-desiccant to trees and shrubs using power spray to provide an adequate film over trunks, branches, stems, twigs and foliage to protect during digging, handling and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with anti-desiccant at nursery before moving and again 2 weeks after planting.

E. In areas that receive inert mulch, apply herbicide in accordance with manufacturer's recommendations.

1. Herbicide: Pre-emergent/Post-emergent: Commercial grade conforming to State and Federal regulations.

2. Cover areas with weed barrier. Weed barrier shall be a non-woven, geotextile fabric.

3. Overlap edges of weed barrier a minimum of 6 inches.

4. Install a 2-1/2 inch uniform layer of inert mulch.

5. Recess area so that top of rock is flush with grass, walks or curbs.

6. If plants are installed during same time that inert mulch is installed, delay herbicide application 3 to 4 weeks.

3.03 PLANTING BED ESTABLISHMENT

A. Loosen subgrade of planting beds to a minimum depth of 8 inches. Remove stones larger than one inch in any dimension and sticks, roots, rubbish and other extraneous matter.

1. Apply superphosphate fertilizer directly to subgrade before loosening.

2. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.

a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days

b. Mix lime with dry soil before mixing fertilizer

B. Topsoil Amendment, Topsoil Placement, and Fine Grading:

1. Place and spread topsoil to a minimum uniform thickness of 4 to 5 inches throughout areas designated to receive landscape planting, allowing for addition of amendments and plant materials, and mulch where indicated.

a. Provide imported topsoil needed to fill remainder of site planting areas to finish grade.

2. Amend new topsoil according to the following: At each 1,000 square feet or per 20 cubic yards, spread 6 cubic yards soil amendment, 15 pounds commercial fertilizer, 10 pounds soil sulfur and 10 pounds iron sulfate evenly over topsoil at rates and depths indicated, then uniformly and thoroughly incorporate into the upper 6 inches of soil to obtain a homogeneous soil mix. Topsoil shall be in a moist condition at time of mixing.

a. Amendment and fertilizer may be premixed prior to placement of topsoil.

b. Modify quantities of soil sulfur, iron sulfate, and soil amendment in accordance with recommendations in topsoil analysis.

3. Deposit and spread topsoil using methods that will prevent excessive compaction of topsoil.

4. Provide a smooth finish grade by blading, dragging or other methods acceptable to the Engineer. Remove high spots and fill depressions. Place grades, slopes and mounds to drain as shown on the Contract Drawings.

a. Finely finish surfaces by raking smoothly and evenly, removing all exposed, extraneous matter one inch or larger in size to facilitate natural runoff. Drag areas for smooth surface.

b. Slope finish grades to drain without water pockets or irregularities (bumps or hollows). Finish grades shall meet all existing controls and shall be 3 inches below adjacent top of paving, curbs or sidewalks to allow for top dressing mulch or 5 inches below top of paving, curbs or sidewalks to allow for rock mulch. Grades shall be of uniform slope between points of fixed elevation. Establish vertical curves or roundings at abrupt changes in slope.

c. Obtain the Engineer's review and approval of finish grades prior to commencing the planting operations.

C. Restore planting beds if eroded or otherwise disturbed after finish grading and before planting.

3.04 TREE AND SHRUB EXCAVATION

A. Excavate circular pits with sides sloped inward. Trim base leaving center area raised slightly to support root ball and assist in drainage. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation.

1. Excavate approximately 3 times as wide as ball diameter for container-grown stock.

2. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.

3. If drain tile is shown or required under planted areas, excavate to top of porous backfill over tile.

B. Do not use subsoil removed from excavations as backfill. Use planting soil (see definitions).

C. Notify the Engineer if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations. Make adjustments to location of pit in consultation with the Engineer and excavate new pit.

D. Notify the Engineer if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.

E. If hardpan layer is encountered, drill 6-inch diameter holes into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.

F. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.05 TREE AND SHRUB PLANTING

A. Set container-grown stock plumb and in center of pit or trench with top of root ball one inch above adjacent finish grades.

1. Carefully remove root ball from container without damaging root ball or plant.

2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.

B. Apply 2 inches average thickness of organic mulch extending 12 inches beyond edge of planting pit or trench. Do not place mulch within 3 inches of trunks or stems.

3.06 TREE AND SHRUB PRUNING

A. Prune, thin and shape trees and shrubs according to standard horticultural practice.

B. Prune trees to retain required height and spread. Do not cut tree leaders; remove only injured or dead branches from flowering trees. Prune shrubs to retain natural character. Shrub sizes indicated are sizes after pruning.

3.07 STAKING

A. Upright Staking and Tying: Stake trees of 2 inches through 5 inches caliper. Stake trees of less than 2 inches.

B. General: Stake or guy trees immediately after planting. Make modifications to staking procedures as required to accommodate field conditions.

1. Allow 1 to 3 inches sway in trunk or branches; do not pull tight

C. Guying and Staking: Staking (metal): Stake trees according to tree stake manufacturer's recommendations.

3.08 GROUND COVER AND PLANTING

A. Set out and space ground cover and plants as shown on the Contract Drawings.

Place 12 inches apart if no other spacing is shown on the Contract Drawings.

B. Dig holes large enough to allow spreading of roots and backfill with planting soil.

C. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

D. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

E. Protect plants from hot sun and wind. Remove protection if plants show evidence of recovery from transplanting shock.

3.09 PLANTING BED MULCHING

A. Mulch backfilled surfaces of planting beds and other areas indicated.

B. Organic Mulch: Apply 2 inches average thickness of organic mulch and finish level with adjacent finish grades. Do not place mulch against plant stems.

3.10 CLEANUP AND PROTECTION

A. During exterior planting, keep adjacent paving and construction clean, and work area in an orderly condition.

B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and any other adjacent work. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged exterior planting.

3.11 DISPOSAL

A. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash and debris, dispose of it in accordance with GC7.15, Disposal of Material Outside the Work Site.

END OF SECTION

SECTION 02910
PLANTING IRRIGATION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for automatic irrigation system.

B. Design Criteria:

1. The irrigation system shall be a point-source drip and bubbler head system. All drip irrigation emitters shall be pressure compensating or have pressure compensating devices installed that ensure uniform output. Final pressure to emitters shall fall within the manufacturer's specification range.

2. Plant material shall be irrigated in groups of similar water requirements taking into account the species and the microclimate conditions. Each group, or hydrozone, shall be on its own circuit and controller station.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. D1784 Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride)(PVC) Compounds and Chlorinated Poly(Vinyl Chloride)(CPVC) Compounds

2. D1785 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

3. D2241 Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

4. D2464 Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

5. D2466 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40

B. National Sanitation Foundation (NSF)

1.03 SUBMITTALS

A. Materials list: Submit materials list. Include manufacturer, model number and description of all materials and equipment. Include sealants, cements, lubricants and other proprietary items.

B. Shop drawings: Submit shop drawings and supporting design calculations for assemblies not detailed on the Contract Drawings. Include mounting details for rain shutoff.

C. As-Built Planting Irrigation Drawings: Submit as specified in Section 01720, Contract Record Documents. The following requirements are in addition to those specified in Section 01720, Contract Record Documents:

1. Show every change from Contract Drawings and Specifications and exact as-built locations, sizes and kinds of equipment.

2. Dimension from 2 permanent points of reference such as building corners, sidewalks, road intersections or monuments to the following items:

a. Connection to water source

b. Valves (ball valves, remote control valves, quick coupling valves)

c. Routing of pressure lines

d. Controller

D. Operation and Maintenance Manuals: Submit Operations and Maintenance Manuals. Include the following data:

1. Copy of Controller Charts: Include full size and reduced versions of each chart as mounted in Controllers. Reduced versions shall be either 8 1/2 inches by 11 inches or 11 inches by 17 inches sheets, folded. Fold full size version and enclose in clear plastic pocket in manual binder.

1.04 QUALITY ASSURANCE

A. Installer of irrigation systems shall be a licensed Landscape Contractor.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic piping protected from direct sunlight. Support piping to prevent sagging and bending.

1.06 SEQUENCING AND SCHEDULING

A. Coordinate sprinkler piping with planting work specified in Section 02900, Planting.

B. Coordinate sprinkler piping with grading and utility work.

1.07 WARRANTY

A. Refer to General Provisions GC4.3, Guaranty of Work. The Guaranty of Work shall include the following provisions in regard to planting irrigation system:

1. Agree to repair or replace defective Work including adjacent work which is damaged by such defects, with the exception of ordinary wear and tear, abuse or neglect. This includes damage to site improvements caused by settlement of improperly compacted trench backfill.

1.08 MAINTENANCE MATERIALS

A. Special tools: Deliver two sets of special tools as required to operate, adjust, dismantle or repair equipment. Include tools not normally found in possession of maintenance personnel. At minimum provide the following:

1. Two sets of special tools and valve keys required for operating, removing, disassembling and adjusting each type of valve supplied on the Project.

2. Two quick coupler keys and matching hose swivels.

1.09 MAINTENANCE SERVICE

A. Maintain irrigation system in working order from beginning of work until the end of the Maintenance Period specified in Section 02900, Planting. Maintenance of system includes, for example, the following work: Flushing system and adjusting heads; providing optimum amounts of water to plants; replacing lost, stolen or damaged equipment; reprogramming controller.

1. In addition to hand watering required in Section 02900, Planting, for plant establishment. During any times when irrigation is not available due to maintenance of irrigation system, hand water as required for maintaining plants.

PART 2 - PRODUCTS

2.01 PVC PIPE AND FITTINGS

A. Polyvinyl Chloride (PVC) Pipe: NSF approved, Type 1, Grade 1 PVC compound; ASTM D1784, ASTM D1785 and ASTM D2241.

B. Pipe shall bear the following markings:

1. Manufacturer's name

2. Nominal pipe size

3. Schedule or class

4. Pressure rating in PSI

5. Date of extrusion

C. Pressure Main Line Pipe: PVC 1120 plastic pipe: Class 315 for 1 1/2 inch and larger; schedule 40 for 1 1/4 inch and smaller.

D. Lateral Line Pipe: PVC 1120 plastic pipe. Class 200 for 3/4 inch and larger.

E. Sleeves (Twice the diameter of working pipe):

1. Water lines: Schedule 40 PVC 1120

2. Electrical lines: Gray, schedule 40 PVC conduit

3. Caps: Schedule 40 PVC

F. Fittings:

1. Solvent weld socket fittings: Schedule 40, Type 1, Grade 1, NSF approved, ASTM D2466. Schedule 80, ASTM D2464. Fittings shall bear manufacturer's name or trademark, material designation, size, applicable IPS schedule and NSF seal of approval.

2. Solvent cement and primer for PVC solvent-weld pipe and fittings shall be of type and installation methods recommended by pipe manufacturer.

G. Risers: Schedule 80 PVC threaded nipples and elbows.

2.02 OTHER PIPING MATERIALS

A. Pipe upstream of (backflow preventer/master valve): Schedule 40 galvanized steel.

B. Pipe Wrapping Tape:

1. Metal pipe: 2-inch wide, 20 mils thick, black PVC, all weather corrosion-resistant tape with high tack adhesive formulated to resist corrosion. Use same manufacturer's pipe primer to seal pipe and prepare for tape wrapping.

2. PVC pipe: As above, except primer is not required.

C. Pipe Joint Compound: Non-hardening, non-toxic, designed specifically for use on PVC and metal threaded connections in water carrying pipe and as recommended by pipe manufacturer.

D. Flexible Riser/Connector: EPDM rubber hose, PVC ends, with stainless steel bands. Product specifically marketed for irrigation systems such as Flex-Riser, King Brothers Industries, or Engineer approved equal.

E. Provide dielectric fittings where dissimilar metals come into contact.

F. PVC Sleeves: Schedule 40 PVC

G. Galvanized Steel Sleeve: ASTM A53

2.03 VALVES

A. Ball valve: Brass construction, stainless steel ball, two-piece body, threaded connections, with teflon seats and full port.

B. Plastic electric remote control valve:

1. Heavy-duty, stainless steel fasteners, nylon-reinforced rubber diaphragm

2. Normally closed with manual internal bleed; self-flushing stainless steel screen and brass flow control stem

3. Rated to 150 psi

4. 24 Vac solenoid actuated

5. All remote control valve manifolds shall have both pressure compensating devices and filters.

C. Quick coupling valves: Bronze construction, 1 inch connection, two-piece body, yellow vinyl locking top, single slot and lug. Size: As indicated on the Contract Drawings.

D. Inline Wye Filter

1. Specifically for low flow applications

2. Rated to 150 psi

3. Standard 200 mesh screen

4. Shall not exceed 5 inches high, 6 inches long, and 2 1/2 inches wide

E. Inline Pressure Regulator: Rated not less than 80 psi.

2.04 VALVE BOXES

A. High Density Polyethylene (HDPE), green, UV resistant, with stainless steel bolt-down mechanism and heat-branded letters, minimum 2 inch height.

1. Remote control valves and gate valves: 12 inches by 18 inches, series 1419 B. Letters: "ICV" and the valve number.

2. Quick coupling valve (QCV): Round, 10 inch diameter, series 910. Letters: "QCV".

2.05 SPRINKLER HEADS

A. Spray Sprinkler:

1. Matched precipitation rate, seamless molded plastic, with stainless steel adjustment screw and retraction spring.

2. Pressure activated wiper seal and removable flushing plug.

3. Pop-up body shall have pressure regulator for 30 psi pressure regulation to nozzle and integral check valve capable of preventing low-head drainage up to 8 feet of head.

4. Pop-up height: 6 inches in shrub and groundcover areas.

5. Nozzle: As shown on the Contract Drawings. Provide pressure compensating screen where required to reduce radius.

2.06 SUBSURFACE DRIP SYSTEM EQUIPMENT

A. Provide all components required for complete system to suit field conditions. All components shall be of single manufacturer.

1. Pressure regulator: Plastic, in-line serviceable, with built-in gauge, rated for 2.0 to 20 gpm.

2. Filter: Plastic, Y body, 200 mesh, composed of stacked thermoplastic discs. Maximum pressure loss: 5.87 psi at 17 gpm.

3. Air relief valve: Plastic, 1/2 inch MPT

4. Tubing: Low density 5/8 inch polyethylene with Rootguard; 0.71 O.D.; 0.62 I.D. Shall have integral, pressure compensating, self-cleaning emitters, 12 inches on center. Emitter flow: 1.02 gph. Shall maintain constant flow at inlet pressure of 5 to 50 psi. Provide fittings, staples adapters and other components of same manufacturer.

5. Line flushing valve: Plastic, 1 gpm, 1/2 inch MPT inlet, shall flush automatically at start of each cycle.

6. Stainless steel clamp: Type 304 stainless steel, screwed hose clamps, as recommended by manufacturer of subsurface irrigation system.

7. Emitter – Multi-Outlet Device – 8 Port, with 1/2 inch inlet

8. The number of emitters installed at each plant shall be calculated based on the plant size and type.

2.07 BACKFLOW PREVENTION DEVICE

A. Reduced pressure type, bronze with 304 stainless steel springs, with two (2) ball valves, pressure rated to 175 psi, 1-inch size.

2.08 CONTROLLER

A. UL listing; pedestal mount, as shown on the Contract Drawings. Controllers shall be factory mounted in manufacturer's enclosure unless otherwise shown.

B. Solid state, microprocessor-based, capable of fully-automatic, semi-automatic or manual operation.

C. Programming: 24 Station. Station timing: 1 minute to 99 minutes in 1 minute increments. Non-volatile memory.

D. Master valve/pump start circuit and valve test function

E. Water budgeting: 0 - 200 percent

F. 6 starts per program per day

G. Standby watering schedule

H. Rainbird, ESP-LX Series with locking steel cabinet, or Engineer approved equal

I. Controller charts: Provide controller charts the maximum size that the controller door will allow, showing areas covered by each controller. Color code area of coverage of each valve and enlarge valve sequence to be readable when drawing is reduced. Reduce approved As-Built drawings and seal between two 20-mil plastic sheets; install inside door.

J. Provide compatible moisture sensor and probe.

2.09 FLOW SENSOR

A. Schedule 80 PVC with removable, non-magnetic sensing mechanism. Rated to 100 psi at 140 degrees F.

B. Sensing mechanism: Electronic detector, glass reinforced polyphenylene sulfide housing with glass reinforced nylon impeller, UHMWPE bearing, tungsten carbide shaft, and EPDM O-rings.

2.10 CONTROL WIRE

A. Control wire: Soft-annealed, uncoated copper, single conductor, with PVC insulating jacket, UL approved for direct burial, size and color as follows:

1. Common ground: White, size #12 AWG-UF

2. Control wire: Color other than white, size #14-1 AWG-UF

B. Provide separate common ground for each controller.

C. Connections: Gel-sealed waterproof connector kit, UL listed for direct burial splices, with spring connector, vinyl insulator and moisture proof snap top packet. DBY/DBR connector sealing packs, as manufactured by 3M Company, Austin, TX, or equal.

2.11 RAIN SENSOR

A. Rain Sensor: Hygroscopic disks housed in UV stabilized, thermoplastic housing with weatherproof switch mechanism and 6 inch aluminum mounting bracket, with automatic return to normal watering cycle, as manufactured by Glen Hilton, Products, Inc, Richmond, VA, or equal.

B. Click stop settings shall measure rainfall in quantities of 1/8 to 1 inch and shut off watering cycle during rain. Set device to shut off system when rainfall reaches 1/2 inch.

C. Shall be low voltage, UL listed, with 25 feet of No. 20 AWG 2 conductor wire and lead wire for normally open wiring. Provide additional mounting hardware and wiring to suit project conditions.

2.12 TRENCH BACKFILL

A. Trench backfill in planting areas shall be planting mix specified in Section 02900, Planting.

B. Trench backfill under paving shall meet requirements of Section 02300, Earthwork.

2.13 OTHER MATERIALS

A. Concrete: As specified in Section 03300, Cast-in-Place Concrete. Minimum compressive strength: 3,000 psi.

B. Drain rock: 3/4 inch washed drain rock.

PART 3 - EXECUTION

3.01 COORDINATION

A. Protect existing and new above and below ground features.

B. Coordinate placement of items to be embedded into concrete work or installed under paving.

C. Design pressure is as shown on Contract Drawings. Verify static pressure at point of connection (POC) before starting construction and notify the Engineer if it is different from the design pressure.

D. Irrigation demand is shown on the Contract Drawings. Verify at POC before starting construction.

E. Verify location and existence of underground utilities. Protect existing utilities from damage. Repair any utility items damaged due to construction activities.

3.02 LAYOUT

A. Drawings: For purposes of clarity and legibility, the Contract Drawings are diagrammatic to the extent that many offsets, bends, unions, special fittings, and exact locations of items are not indicated, unless specifically dimensioned. Exact routing of piping, conduits and wiring shall be governed by actual site conditions.

1. Provide necessary fittings and offsets to adapt to existing conditions and prevent conflicts with other work and existing improvements.

B. Before installation, stake layout of pressure supply lines and valves for review. Coordinate with staked layout of trees provided under Section 02900, Planting. Adjust as required in ensure coverage, to avoid interference with planting.

3.03 BACKFILLING

A. Backfill with specified material after testing pipe. Compact backfill to a density equal to adjacent soil, or as specified in Section 02300, Earthwork.

B. Correct subsequent settlement of trenches, and correct any damage caused by settlement.

3.04 SLEEVES AND CONDUITS

A. Provide sleeves and conduit of sufficient size and quantity to accommodate all pipe and wiring. Install sleeves where control wires and pipe pass through or under walls and under paving. Provide galvanized steel pipe sleeves where sleeves are installed by jacking or boring.

B. Install minimum 7 inches below bottom of pavement base, and at least as deep as required depth of pipe.

C. Sleeves and caps: Extend minimum 12 inches beyond edge of pavement. In-line fittings are not permitted in sleeves less than 20 feet long. Cap ends of sleeves hand tight until pipe is installed.

1. Install sleeves and conduit level and in a straight line.

D. Backfill with 4 inches clean sand on all sides of sleeves and compact by tamping.

E. Mark locations of sleeve ends with 2 x 4 stake extending 6 inches above finish grade, for future location during construction. Label stake clearly with letter "I". Remove stake when assembly is completed.

3.05 POINT OF CONNECTION/WATER METER

A. Make arrangements and pay costs for installation of water meters at locations indicated on Contract Documents. Coordinate with the jurisdictional authorities and the Engineer.

3.06 BACKFLOW PREVENTION DEVICE

A. Connect backflow prevention device to water supply line in approximate location shown on Contract Drawings.

B. Arrange and pay for tests and certificates required by jurisdictional authorities.

3.07 PIPE

A. General:

1. Install pipe under existing paving by jacking or boring.

2. Do not use pipe joint compound on sprinkler bases or remote control valves.

3. Cap open pipe ends as pipe line is assembled to keep out soil or debris. Remove caps only when necessary to continue assembly.

4. Sleeve pipe under paving. Where pipes or control wires pass through sleeves, provide removable non-decaying plug at ends of sleeves to keep soil out.

5. Pipe wrapping: Wrap galvanized pipe and fittings in contact with soil and to 3 inches above soil line. Overlap tape 1/2 its width.

6. Provide check valve where required to prevent erosion from low head drainage.

B. Solvent-weld PVC:

1. Install plastic pipe as recommended by manufacturer, including accommodating expansion and contraction.

2. Install PVC pipe in trench with manufacturer's markings facing up.

3. Cut pipe ends square and remove burrs. Pipe and fitting shall be free of dirt, dust and moisture.

4. Dry-insert pipe into fitting to check fit. Pipe should enter fitting 1/3 to 2/3 depth of socket.

5. Apply primer to socket and pipe end. Apply heavy coat of cement to pipe end. Apply light coat of cement to inside of socket and second coat to pipe end.

6. Insert pipe into fitting and turn 1/4 turn until pipe seats to the bottom of the socket. Check alignment of pipe and fitting.

7. Hold joint still for 30 seconds and remove excess cement.

8. Cure joint minimum 30 minutes before handling and 6 hours before filling with water.

C. Threaded joints:

1. Field threading of plastic pipe or fittings is not permitted. Use factory-made threads only.

2. Use factory-made metal nipples wherever possible. Field cut threads in metal pipe may be used only where approved by the Engineer. Cut threads accurately on axis with sharp dies.

3. Apply pipe joint compound to male threads and first 3 female threads.

4. On metal to metal joints, no more than 3 full threads shall show when joint is complete.

5. When assembling threaded plastic fittings, tighten joint no more than one (1) full turn beyond hand tight. Use strap type friction wrench only; do not use metal-jawed wrench.

3.08 VALVES

A. General:

1. After pipe and risers are in place and connected and before installation of valves, flush out system with a full head of water. Lines shall be free of soil or debris.

2. Locate and install as shown. Obtain Engineer's approval of location of valves and alignment of boxes.

B. Valve Box Installation, General:

1. Install boxes 18 inches from walk or header and 12 inches apart. Short side of rectangular boxes shall be parallel to walk or header. Install boxes 2 inches above finish grade in groundcover areas; flush in lawn areas.

2. Install common bricks as shown and as required to keep box stable. Place 3/4 inch drain rock inside box for drainage as shown.

3. No soil or accumulated water is permitted in valve boxes. Install PVC tape over box side cutouts.

C. Remote Control Valve:

1. Install where shown on Contract Drawings; group boxes together and install in groundcover areas wherever possible.

2. Install separate box for each valve.

3. Provide a separate riser and connection to mainline for each remote control valve shall have. Do not manifold valves to a single riser from mainline unless shown on the Contract Drawings.

4. Number valves in sequence shown on the Contract Drawings.

5. Label each valve with controller and station number on 2-1/4 inches by 2-3/4 inches polyurethane tag attached to control wire.

D. Quick coupling valve: Set valve perpendicular to finish grade, unless otherwise shown.

3.09 SPRINKLERS

A. Thoroughly flush lines before installing sprinkler heads.

B. Locate and install heads, risers and fittings as shown. Notify the Engineer and adjust layout and provide additional heads, as required, where field conditions or obstructions prevent adequate coverage.

C. Set heads perpendicular to finish grade, unless otherwise shown.

D. Adjust sprinkler heads for proper distribution and trim, providing complete coverage with minimal overspray.

3.10 CONTROLLER

A. Refer to the Sections of Division 16, Electrical, for specifications for power to the controller.

B. Install in approximate location shown on the Contract Drawings. Obtain Engineer's acceptance of exact location. Connect to disconnect switch.

C. Mount enclosure as shown.

D. Connect control wires to controller according to valve numbers shown, in sequence shown on the Contract Drawings. Label each control wire with permanent label showing station number of valve controlled.

E. Rain sensor: Mount in location accepted by the Engineer, as shown on approved shop drawings. Connect according to manufacturer's instructions and wiring diagrams.

F. Control wire:

1. Run lines along mains wherever possible. Provide separate conduit for wires under paving. Tie wires in bundles with 1-inch wide electrical tape at 10-foot intervals and allow slack for contraction between strapping. Tape is not required in sleeves.

2. Loop three (3) feet of extra control and ground wires in 1-inch diameter coil, at each valve, at 100 foot intervals along wire runs, and at changes of direction.

3. Splicing is not permitted.

4. Install spare control wire of different color for each controller along entire main line.

G. Programming: Perform programming throughout construction and maintenance period. Provide optimum amounts of water for each plant type to maintain plants in vigorous healthy condition. Adjust irrigation time to soil type to reduce water runoff. Set watering time between 10 PM and 6 AM. Reprogram as required at end of maintenance period.

3.11 TESTING PIPE

A. Center-load pipe with approved backfill to anchor pipe before testing. Do not cover fittings.

B. Before testing, bleed air out of lines at line pressure. Provide vertical pipe at high points during installation.

C. Do not cover or enclose work until tests are approved by the Engineer.

D. Solvent weld pipe: Test hydrostatically after joints have cured at least 24 hours. Provide caps, pumps, pressure gauges and other equipment required to perform test.

1. Test pressure mainline at 150 psi for 4 hours and prove watertight.

2. Cap sprinkler risers and test lateral lines at line pressure. Review system for leaks.

E. Repair leaks and repeat tests until system is proven watertight.

F. Remake faulty joints with new materials. Do not use cement or caulking to seal leaks. Perform repairs in conformance with the Contract Documents.

3.12 DRIP SYSTEM POST-INSTALLATION CHECK

A. Immediately after installation, flush lateral line piping by removing the last emitter from each line.

B. Clean filter screens. Open filter flush valve for at least 10 seconds. Clean or replace clogged elements.

C. Operation check: While system is operating, check pressure gauge downstream from filter. Pressure shall be minimum 80 percent of supply pressure and minimum 10 percent above the setting of the pressure regulator.

D. Clean or replace filter element as required to obtain specified pressure

E. Adjust pressure regulator to system design pressure.

F. Verify that emitters are producing specified water output. If not, replace emitters, check filter element, check pressure at emitters, and review system for clogs and leaks. Correct deficiencies.

3.13 FIELD QUALITY CONTROL

A. Progress observations: In addition to the observations specified below, the Engineer will make periodic progress observations.

B. Notify the Engineer in advance of the following observation meetings, as indicated:

1. Field layout: 3 days

2. Pressure supply line installation and testing: 48 hours

3. Controller installation: 48 hours

4. Coverage test: 48 hours

5. Maintenance period observations: 7 days

6. Final observation: 7 days

3.14 SYSTEM ADJUSTMENT

A. Flush and adjust sprinkler heads for optimum performance. Prevent overspray onto walks, roadways, paving and buildings. Adjust nozzle sizes and degree of arc, and install pressure compensating screens, as required to cover planting areas without overspray. Adjust valve flow controls.

B. Test and adjust entire system at completion of each phase or section of work.

C. Perform coverage test in the presence of the Engineer to establish that coverage of all planting areas is complete and adequate. Correct deficiencies and repeat test until approved by the Engineer.

3.15 ACCEPTANCE

A. Obtain Engineer's acceptance of irrigation system after irrigation work is complete and after acceptance of planting work as specified in Section 02900, Planting.

B. Operate system during observation by the Engineer.

3.16 OPERATION INSTRUCTION

A. Provide six (6) hours instruction in operation and maintenance of system to Owner's maintenance personnel, after completion and acceptance of irrigation system by the Engineer. Provide instruction by manufacturer's representative where Contractor is not expert in operation of equipment.

END OF SECTION

SECTION 03100
CONCRETE FORMING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for design, construction, and removal of formwork for the placement of cast-in-place concrete.

1.02 REFERENCE STANDARDS

A. American Concrete Institute (ACI):

1. 301 Specifications for Concrete Construction

2. 347 Guide to Formwork for Concrete

B. APA – The Engineered Wood Association (APA)

1. Voluntary Product Standard PS 1-19 Structural Plywood

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

1. Manual for Railway Engineering

D. State of California, Department of Transportation, Standard Specifications, (Caltrans):

1. Section 51 Concrete Structures

1.03 SYSTEM DESCRIPTION

A. The work of this Section shall be performed in accordance with the following provisions:

1. AREMA Manual, Section 1.9, "Forms," of Chapter 8, "Concrete Structures and Foundations"

2. Caltrans Standard Specifications, Section 51-1.03C(2), Forms

3. ACI PRC-347-14(21): Guide to Formwork for Concrete

1.04 SUBMITTALS

A. Formwork Shop Drawings: Submit drawings that indicate the following:

1. Forming system and method of erection with associated details, including bracing as required to ensure stability of formwork.

2. Design calculations for the forming system.

3. Concrete placement rates and ambient temperature requirements at time of concrete placement.

4. Locations of all joints in concrete, including construction joints, expansion joints, isolation joints, cold joints, and contraction joints, in plan and elevation views.

5. Locations and sizes of inserts, embedments, conduits, openings, recesses, chamfers, reveals, rustications, blockouts, pipes, ducts and other attached products.

6. Form ties locations and patterns at exposed cast-in-place concrete.

7. Beam intersections and other conditions where concrete casting by vertical drop may be restricted.

8. Method and schedule for removing forms and shoring.

9. Method for detecting formwork movement during concrete placement.

10. Coordinate with the requirements specified in Section 03300, Cast-In-Place Concrete.

B. Product Data: Provide manufacturers' data and installation requirements on form materials, form coatings, form ties, and other accessories.

1.05 QUALITY ASSURANCE

A. The design of the formwork will be done under the supervision of a civil engineer registered in the State of California.

PART 2 - PRODUCTS

2.01 WOOD FORM MATERIALS

A. Provide form materials in accordance with the requirements of APA PS-1, including the following products:

1. B-B Plyform: Class I, EXT-APA, sanded, APA trademarked.

2. B-C Plyform: Class I, EXT-APA , APA trademarked.

3. High Density Overlay (HDO) Plyform: A-A, 60-60, Class I, EXT-APA trademarked.

4. Thickness: As required to maintain surface smoothness without deflection, but not thinner than 5/8 inch.

B Lumber:

1. Boards: Use dressed side of lumber for surface in contact with the concrete and use dressed or tongue-and-groove edges.

2. Framing Lumber: Structural grade, dressed or rough.

2.02 PREFABRICATED FORMS

A. Preformed forms may be used. Forms shall be structurally adequate, matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces. Provide surfaces which will not impart corrosion residue to concrete.

2.03 FORMWORK ACCESSORIES

A. Plugged Cone Form Ties: Rod type, with ends or end fastener which can be removed without spalling the concrete and which leave a hole equal in depth to the required reinforcement clearance. Form ties shall be of a design in which the hole left by the removed end or end fastener is easily filled to match the surface of the hardened concrete. Provide removable cones 1-1/4 inches in diameter by 1-1/2 inches deep.

B. Form Release Agent: Commercial formulation, silicone-free form-release agent, designed for use on all types of forms, which will not bond with, stain, nor adversely affect concrete surfaces, and which will not impair subsequent treatment of concrete surfaces requiring bond or adhesion nor impede wetting of surfaces which will be cured with water, steam, or curing compounds. Form release agent for use on steel forms shall be non-staining and rust-preventive.

C. Chamfer Strips: 3/4 inch by 3/4 inch triangular fillets milled from clear, straight-grain pine, surfaced each side or extruded vinyl type with or without nailing flange.

D. Miscellaneous Joint Strips: Preformed strips for reveals, rustication and similar joints fabricated of wood, metal, or plastic.

E. Dovetail Anchor Slot: Galvanized steel, 22 gage thick, release tape sealed slots, anchors for securing to concrete formwork.

F. Nails, Spikes, Lag Bolts, Through Bolts, and Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place during concrete placement.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify locations, lines, and levels before proceeding with formwork. Ensure that dimensions agree with shop drawings.

3.02 EARTH FORMS

A. Hand trim sides and bottom of earth forms. Establish and maintain necessary benchmarks, lines, or controls throughout construction. Remove loose soil prior to placing concrete.

3.03 INSTALLATION

A. Erect formwork, shoring and bracing to achieve design requirements and to maintain allowable tolerances in accordance with the requirements of ACI 301.

B. Formwork of foundations shall not interfere with underground utilities, such as fiber optic cables, and railroad track operational clearances.

C. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to over-stressing by construction loads.

D. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping, and permit removal of remaining principal shores.

E. Kerf wood inserts for forming keyways, reglets, and recesses in a manner that will prevent swelling and ensure ease of removal.

F. Align joints and make watertight. Keep form joints to a minimum.

G. Support joints with extra studs or girts and in a manner that will ensure true, square intersections.

H. Provide chamfer strips on external corners of all concrete pours. Accurately shape and surface chamfer strips in a manner which will produce uniformly straight lines and edge joints and which will prevent mortar runs. Extend terminal edges to limits, and miter chamfer strips at changes in direction.

I. Construct molding shapes, recesses and projections with smooth finish materials and install in forms with sealed joints.

J. Provide camber in formwork as required to compensate for deflections caused by weight and pressures of fresh concrete and construction loads.

K. Provide construction openings in forms where required for concrete pour pockets, vibrator access holes and inspection openings to aid in proper placement and consolidation of concrete and close up openings during placement of concrete as applicable.

L. Provide inspection and cleanout openings in forms at bottom of walls and columns and elsewhere as required. Do not close cleanouts until inspected and accepted just before placing concrete.

M. Drill air escape holes in bottom members of blockouts.

N. Ensure that formed stair risers within stair run are equal.

O. Edge Forms and Screeds for Slabs: Set edge forms or bulkheads and intermediate screeds for slabs to obtain required elevations and contours in the finished slab surface. Support screeds substantially without penetrating waterproof membranes and vapor barriers.

P. Construction Joints:

1. Locate joints as indicated. Support forms for joints in concrete so as to rigidly maintain their positions during placement, vibration, and curing of concrete. Install keys in all joints.

2. Locate and install construction joints, for which locations are not indicated, so as not to impair strength and appearance of the structure and in accordance with approved Shop Drawings

3. Position joints perpendicular to longitudinal axis of pier, beam, or slab as the case may be.

4. Locate joints in walls, vertically as indicated; at top of footing; at top of slabs on grade; at bottom of door openings; and at underside of the deepest beam or girder framing into wall; or as required to conform to indicated details.

5. Provide keyways as indicated in construction joints in walls and slabs, and between walls and footings, unless otherwise indicated. Place construction joints perpendicular to the main reinforcement. Continue reinforcement across construction joints.

Q. Load Supports: Loads for construction of roof slab and suspended floor slabs shall be carried down to on-grade base slabs. These loads shall not be carried by intermediate slabs at any time. Formwork loads shall be carried only by structural elements which are supported directly by footings.

3.04 FORM RELEASE AGENT

A. Apply form release agent on formwork in accordance with manufacturer's recommendations, prior to placement of reinforcing steel, anchoring devices, and embedded items. Do not allow excess form release agent material to accumulate in the forms or to come into contact with surfaces which are required to be bonded to fresh concrete such as concrete reinforcement and embedded items.

B. Protect steel forms from rust with form release agent or otherwise protect against rusting.

C. Apply release agent to bolts and rods that are to be removed or that are to be free to move.

3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Provide formed openings for items to be embedded in or passing through formwork.

B. Locate and set in place items that will be cast directly into concrete.

C. Coordinate with related work of other Sections in forming and placing openings, slots, recesses, chases, sleeves, bolts, anchors, ties, inserts, and similar embedded items.

D. Install accessories in accordance with manufacturer's instructions, straight, level, and plumb. Secure items to prevent disturbance during concrete placement.

E. Provide temporary ports or openings in formwork to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

F. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.06 FORM CLEANING

A. Clean and remove foreign matter within forms as erection of formwork proceeds.

B. Clean debris from formed cavities prior to placing concrete.

C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

3.07 FORM STRIPPING

A. Do not remove forms or bracing until concrete members have sufficient strength to safely support their own weight and all superimposed loads.

B. Leave forms supporting elevated structural elements in place for at least 3 days, unless results of tests show that 70 percent of specified strength has been achieved. At times of low temperature or other adverse weather conditions, increase the required time to 5 days.

C. Do not remove or release falsework and forms supporting concrete girders, beams, joists, slabs, walls, or other members subject to bending stress in less than 14 days after the concrete has been placed. In any case, do not remove falsework and forms supporting the members until the concrete has attained at least 70 percent of the indicated design compressive strength on test results of laboratory cured cylinders. Do not load such members until the concrete has attained its 28-day compressive strength.

D. Loosen forms carefully and remove without hammering or prying against finished concrete surfaces.

E. Protect concrete surface from damage. Store removed forms for re-use, as appropriate, and remove damaged forms from the site and dispose of.

F. As soon as the forms have been stripped and the concrete surfaces exposed, commence finishing and repairs such as removal of fins and other projections, filling recesses left by the removal of form ties, and repair surface defects as specified in Section 03170, Concrete Finishing. Clean exposed concrete surfaces and adjoining work stained by leakage of concrete.

3.08 RE-USE OF FORMS

A. Forms that are in good condition and have been cleaned, repaired, and resealed as required to achieve concrete of the specified quality and texture may be

reused if approved by the Engineer. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Remove such material from the site. Renew form release coating as specified for new formwork.

B. Do not reuse wood formwork more than four times for concrete surfaces exposed to view.

C. Align and secure joints in a manner that will preclude offsets. Do not patch formwork unless accepted by the Engineer, in which case, patch holes and defects in forms with materials and methods that will not be reflected in the concrete.

3.09 FIELD QUALITY CONTROL

A. Inspect erected formwork, shoring, and bracing to ensure that the work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure.

B. While placing concrete, provide quality control to assure that formwork and related supports have not been displaced, that loss of cement paste through joints is prevented and that completed work will be within specified tolerances.

C. During removal, verify that architectural features meet the form and texture requirements of the samples approved by the Engineer.

D. Check movement using methods, such as plumb lines, tell tales and survey equipment, as approved by the Engineer, to detect movement of formwork during concrete placement.

END OF SECTION

SECTION 03150
CONCRETE ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section includes specifications for accessories for concrete structures.

1.02 REFERENCE STANDARDS

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

1. Manual for Railway Engineering

B. State of California, Department of Transportation, Standard Specifications (Caltrans):

1. Section 51 Concrete Structures

2. Section 68 Subsurface Drains

3. Section 75 Miscellaneous Metals

4. Section 95 Epoxy

1.03 SUBMITTALS

A. Submit product data and manufacturer's instructions for elastomeric bearing pads, joint seals, waterstops, mortar, epoxies, and other items.

1.04 DELIVERABLES

A. Certificates of Compliance: Submit certificates of compliance for joint seals and elastomeric bearing pads.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Concrete Anchorage Devices, Bolts, threaded rods, and Inserts: Conform to the provisions of Caltrans Standard Specifications, Section 75, Miscellaneous Metal.

B. Expansion Joints, Joint Fillers and Sealers: Conform to the provisions in Caltrans Standard Specifications, Section 51, and AREMA Manual, Chapter 8. See Section 07250, Joint Sealants, for additional requirements.

C. Elastomeric Bearing Pads: Elastomeric bearing pads for railroad bridges shall conform to the details shown on the Contract Drawings and the requirements of AREMA Manual, Chapter 15, and the following additional requirements:

1. Elastomeric bearing pads shall be plain pads as specified in Caltrans Standard Specifications, Section 51, unless otherwise indicated, with a thickness as dimensioned on the Contract Drawings.

2. Provide holes as shown on the Contract Drawings for pads located at girder anchor rods.

3. Adhesive: Adhesive for the installation of bearing pads to concrete and steel bearing surfaces must be a solvent-free adhesive that is appropriate for the specific installation, as shown on the Drawings.

D. Waterstops: Conform to the provisions in Caltrans Standard Specifications, Section 51-2.04 Waterstops.

E. Mortar: Conform to the provisions in Caltrans Standard Specifications, Section 51-1.02F, Mortar.

F. Drain Pipe: Conforming to the provisions for pipe for edge drains and edge drain outlets in Caltrans Standard Specifications, Section 68-4, Edge Drains.

G. Embedded Junction Boxes and Conduit: Refer to Division 16, Electrical.

H. Embedded Drains, Drain Pipes, Reducers, and Fittings: Refer to Section 02630, Storm Drainage System.

I. Gel-Type Epoxy: Delta AS23-18 A&B gel-type epoxy or Engineer approved equal.

J. Epoxy binder: Conforming to the provisions in Caltrans Standard Specifications, Sections 95-1, General, and 95-1.02C, Epoxy Binder.

K. Steel-Reinforced Elastomeric Bearing Pads: Steel-Reinforced Elastomeric Bearing Pads shall conform to the details shown on the Contract Drawings and the requirements of AREMA Manual, Chapter 15.

L. Joint Seals: Conform to the provisions in Caltrans Standard Specifications, Section 51-2.02, Sealed Joints.

2.02 MORTAR AND GROUT MIXES

A. Gel-Type Epoxy Sand Mortar: Mix mortar consisting of equal parts by volume of gel-type epoxy and dry silica sand in accordance with manufacturer's instructions.

B. Epoxy Grout: One part epoxy binder to three parts dry silica sand (fine aggregate), by volume.

C. Grout for baseplates and bedplates: Refer to Section 03300, Cast-In-Place Concrete.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Coordinate installation of accessories with Section 03300, Cast-in-Place Concrete, and related concrete sections.

B. Elastomeric Bearing Pads:

1. Bond pads to abutment seats and pier caps with epoxy.

2. Clean top and bottom surface of bearing pads with methyl ethyl ketone to remove all traces of mold release agents. When mating surfaces are clean and dry, apply gel-type epoxy to a 5 mil thickness on the bridge seat and the bottom side of the bearing pad and then set pad and hold in the proper location on the bridge seat until the epoxy takes its initial set.

3. Just before setting beams, spread gel-type epoxy sand mortar on top of bearing pads to a thickness of approximately 1/4 inch to obtain uniform bearing. Scrape excess mortar from around bearing pads after beams are set.

C. Waterstops: Install waterstops as specified in Caltrans Standard Specifications, Section 54-4.03 Construction, and waterstop manufacturer's written instructions.

D. Epoxy Grout: Apply where indicated on the Contract Drawings. Use in accordance with manufacturer's instructions:

1. Follow manufacturer instructions regarding maximum pot life. In the event of high air temperatures, the time shall be shortened so that placement of the grout occurs while the material is still sufficiently liquid to adhere.

E. Joint Seals: Install joint seals as specified in Caltrans Standard Specifications, Section 51-2.02, Sealed Joints.

END OF SECTION

SECTION 03160
COLORED CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for integrally colored concrete.

1.02 GENERAL

A. Provisions herein augment requirements specified under Sections 03300, Cast-in-Place Concrete, and 03170, Concrete Finishing, to add provisions specific to integrally colored concrete.

1.03 REFERENCES

A. ASTM International (ASTM):

1. C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

2. C979 Standard Specification for Pigments for Integrally Colored Concrete

1.04 SUBMITTALS

A. Submit product data and manufacturer's instructions for:

1. Color additives

2. Curing compounds

3. Mixing, delivery, placement, and finishing

B. Samples for Color Verification:

1. Submit 8 inch by 10 inch by 2 inch samples (or comparable size approved by the Engineer) of specified colors indicating color additive number(s) and required dosage rate(s).

C. Concrete Mix Designs: Submit under Section 03300, Cast-in-Place Concrete.

1.05 QUALITY ASSURANCE

A. Maintain consistency in workmanship throughout colored concrete work.

B. Installer Qualifications: Colored concrete work shall be performed by firm with five years' experience with work of similar scope and quality.

C. Colored Concrete Mock-Up:

1. Provide full-scale mock-up for the Engineer's approval. Construct at least one month before observation and review to allow concrete to cure.

2. At location selected by the Engineer, place and finish 4 foot by 4 foot area for each concrete color and finish. Demonstrate methods of obtaining consistent visual appearance, including each forming and finishing condition required on Project using materials, workmanship, joint treatment, form ties, curing method, sealants, joint sealants, and patching techniques to be used throughout Project at color concrete.

3. Include specified concrete coverings, sealers, etc. as part of the mock-up if requested by the Engineer.

4. Retain samples of cements, sands, aggregates, and color additives used in mock-up for comparison with materials used in remaining Work. Make available to the Engineer upon request.

5. Accepted mock-up areas will be the visual standard for work of Section.

6. Remove when no longer required for comparison with finished work.

1.06 DELIVERY, STORAGE AND HANDLING

A. Color Additives: Comply with manufacturer's instructions. Deliver color additives in original, unopened packaging. Store in dry conditions.

1.07 PROJECT CONDITIONS

A. Colored Concrete Environmental Requirements:

1. Schedule placing to minimize exposure to wind and hot sun before curing materials are applied.

2. Avoid placing concrete if rain, or frost is forecast within 24 hours. Protect fresh concrete from moisture and freezing.

B. Schedule delivery of concrete to provide consistent mix times from batching until discharge.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cement, Water, and Other Admixtures: Refer to Section 03300, Cast-in-Place Concrete. Obtain each material, including cement and aggregates, from same source throughout color concrete work.

B. Cement: Cement shall be grey or white, as specified in the Contract Documents and as required to match samples available with the Engineer.

C. Integral Color Concrete Pigment: Conforming to ASTM C979, resistant to lime and other alkali, resistant to sunlight, and inorganic, and containing no carbon black. Provide ready-to-use, integral color material. Color additives shall contain pure, concentrated mineral pigments specially processed for mixing into concrete.

1. Colors: To match samples available with the Engineer, utilizing cement, aggregates, and pigmented additive specified in the Contract Documents.

D. Curing Compound for Colored Concrete: Curing compound shall comply with ASTM C309 and be approved by color additive manufacturer for use with colored concrete.

E. Form Facing Materials: Refer to Section 03100, Concrete Forming, for general requirements.

1. For formed colored concrete surfaces, provide non-porous surface such as steel, plastic, or high-density overlaid plywood with watertight joint seals to prevent leakage.

F. Sealants for Colored Concrete: Joint sealants shall be type specified in Section 07250, Joint Sealants. Provide in color to match colored concrete.

2.02 CONCRETE MIX DESIGNS

A. Concrete mix design shall conform to the requirements specified in Section 03300, Cast-in-Place Concrete, and the following additional requirements:

1. Match the sample available with the Engineer, utilizing the cement, aggregates, and pigmented additive specified in the Contract Documents.

2. Use of admixtures, in addition to pigmented additive itself, shall be subject to the written approval of the color additive manufacturer.

3. Dosage rate of color additive shall not exceed 10 percent of weight of cementitious materials in mix.

B. Maintain water content and control slump to maintain constant color.

C. Color Additives: Mix in accordance with manufacturer's instructions. Mix until color additives are uniformly dispersed throughout and disintegrating bags, if used, have disintegrated.

D. Patching Mix: If any patching is permitted, mix according to pigmented additive manufacturer's written instructions. Refer to Section 03170, Concrete Finishing, for additional requirements for patching.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Refer to Sections 03300, Cast-in-Place Concrete, and 03170, Concrete Finishing, for general requirements for finishing and curing concrete.

B. Finishing and Curing of Colored Concrete:

1. Finish in accordance with color additive manufacturer's written instructions and Section 03170, Concrete Finishing.

2. Colored Concrete: Cure in accordance with color additive manufacturer's recommendations. Apply curing compound in accordance with curing compound manufacturer's instructions. Apply curing compound at consistent time for each pour to maintain color consistency.

C. Protect surrounding exposed surfaces during placement, finishing, and curing activities of colored concrete.

D. If more than one concrete pump is used to place concrete, designate the pumps to receive colored concrete. The designated pumps must receive only colored concrete throughout the concrete placement operation.

END OF SECTION

SECTION 03170

CONCRETE FINISHING

PART 1 – GENERAL

1.01 DESCRIPTION

A. This Section includes specifications for the finishing and curing of formed and unformed concrete surfaces, including the repair of surface defects.

1.02 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1. M182 Standard Specifications for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

B. American Concrete Institute (ACI):

1. 117 Specifications for Tolerances for Concrete Construction and Materials

2. 301 Specifications for Concrete Construction

3. 308R Guide to External Curing of Concrete

4. 503.4 Standard Specification for Repairing Concrete with Epoxy Mortars

C. ASTM International (ASTM):

1. C33 Standard Specification for Concrete Aggregates

2. C150 Standard Specification for Portland Cement

3. C171 Standard Specification for Sheet Materials for Curing Concrete

4. C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

5. C881 Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete

1.03. SYSTEM DESCRIPTION

A. Finishing of formed concrete surfaces shall conform to applicable requirements of ACI 301.

B. Finishes for slabs and flatwork shall conform to applicable requirements of ACI 301.

C. Special architectural finishes for formed concrete surfaces shall conform to applicable requirements of ACI 301.

1.04. SUBMITTALS

A. Product Data: Submit manufacturers' product data for manufactured products.

B. Samples: Review by the Engineer will be for color and texture only. Approved samples will become the Engineer's control samples.

1. Submit samples at least 12 inches by 12 inches in size of each type of sand blast finish, indicating materials and methods used to produce the sand blast finishes.

2. Submit samples of seeded aggregate where washed aggregate finish is indicated.

C. Submit procedures to achieve uniform treatment of construction joints.

1.05. QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with air pollution regulations of governing authorities for sandblasting activities and operations.

B. Site Mock-Ups:

1. Exposed Finishes: Provide site mock-ups, at least 3 feet by 4 feet in size, of finishes of formed surfaces in exposed locations and of exposed slab finishes for the Engineer's approval.

2. Architectural Concrete: Provide site mock-ups of architectural concrete, at least 8 feet by 10 feet in size, showing finish texture and pattern of exposed formed concrete surfaces for Engineer’s approval.

3. Include specified concrete coverings, hardeners, sealers, etc. as part of the mock-up if requested by the Engineer.

4. Provide the number of mock-up panels required necessary to obtain the Engineer's approval of pattern, texture, and color of panel.

5. Maintain approved mock-ups and use as the standard for the aesthetic quality of the surface finish for work represented by mock-ups. Remove mock-ups when permitted by the Engineer.

6. Refer to Section 03160, Colored Concrete, for additional mock-up requirements for integrally colored concrete.

PART 2 - PRODUCTS

2.01 REPAIR AND FINISHING MATERIALS

A. Portland Cement: ASTM C150, Type I or II, of same brand as used in the work. Furnish white Portland cement where required to produce color matching color of surrounding concrete.

B. Aggregate:

1. For Bonding Grout: ASTM C33, washed clean sand passing a No. 30 sieve.

2. For Patching Mortar: ASTM C33, washed clean, graded fine aggregate of suitable size for areas to be repaired. Clean coarse aggregate up to Size No. 8 may be added for repair of larger pockets and voids.

3. For Washed Aggregate Finish: Washed clean, match approved sample.

C. Commercial Patching Mortar: A structural repair mortar may be furnished if appropriate for the use and approved by the Engineer.

D. Epoxy Patching Mortar: As specified in ACI 503.4 for Epoxy Mortar.

E. Epoxy Adhesive: ASTM C881, Type II or Type V, epoxy-based bonding agent.

F. Color Hardener: As specified in the Contract Documents.

2.02 REPAIR MIXES

A. Bonding Grout: 1 part Portland cement to 1 part No. 30 mesh sand, mixed to the consistency of a thick cream.

B. Patching Mortar: Make the patching mortar of the same materials and of approximately the same proportions as used for the concrete, except omit the coarse aggregate. Use not more than 1 part Portland cement to 2-1/2 parts sand by damp loose volume, and substitute white Portland cement for a portion of the regular gray Portland cement to produce patching mix matching the surrounding concrete in color when dry. Determine the proportion of white Portland cement by trial mixes and test areas, prior to repair of actual defective areas.

2.03 CURING MATERIALS

A. Damp Curing Materials: Non-staining.

1. Waterproof Sheet Materials: ASTM C171, waterproof paper with white paper face, polyethylene film pigmented white, or white burlap-polyethylene sheeting.

2. Burlap: AASHTO M182, of class or weight suitable for the use and location. Do not use burlap where concrete is exposed to direct sunlight.

B. Curing Compound: ASTM C309, liquid membrane-forming curing compound, Type I, Class A or B, as appropriate for the use or location.

1. Where concrete surfaces will receive architectural finishes, such as resilient floor coverings, paint, or membrane waterproofing, membrane-forming curing compound shall not leave a coating or residue which will impair bond of adhesives, paints, and coatings with concrete.

C. Curing Compound for Colored Concrete: For concrete colored with color hardener, use curing compound recommended by the manufacturer of the color-hardener

material. For integrally colored concrete, refer to Section 03160, Colored Concrete, for curing compound.

PART 3 - EXECUTION

3.01 REPAIR OF SURFACE DEFECTS

A. Repair Standards: Repair of surface defects shall conform to applicable requirements of ACI 301. When using epoxy mortar, conform to applicable requirements of ACI 503.4.

B. Surface Defects:

1. Begin repair of surface defects immediately after form removal. For repair with epoxy mortar, concrete shall be dry.

2. Surface defects are defined to include: form-tie holes, air voids and pockets, bug holes with a nominal diameter or depth greater than 1/4-inch, honeycombed areas, rock pockets, visible construction joints, fins and burrs.

3. Repair of surface defects shall be tightly bonded and shall result in concrete surfaces of uniform color and texture, matching adjacent surfaces, and free of shrinkage cracks.

C. Repair Work:

1. Remove honeycombed and other defective concrete down to sound concrete. Saw-cut the edges perpendicular to the surface or slightly undercut. Feather-edges will not be permitted. Dampen the area to be patched and an area at least 6 inches wide surrounding it to prevent absorption of water from the patching mortar.

2. Where rock pockets or similar defects or voids expose steel reinforcement, cutout to solid surface behind the reinforcing steel to provide suitable key-lock for patching mortar. Envelop exposed reinforcing bar with patching mortar.

3. Bond patching mortar to concrete with bonding grout or epoxy adhesive. Brush bonding grout well onto the concrete. Bond commercial patching mortar to concrete in accordance with the manufacturer's instructions.

4. After surface water has evaporated from the area to be patched, brush the bond coat well into the surface. When the bond coat begins to lose the water sheen, apply the patching mortar. Compact the mortar into place and strike off so as to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, leave the patch undisturbed for at least 1 hour before being finally finished. Keep the patched area damp for 7 days.

5. Neatly finish patched surfaces to match adjacent surrounding surface texture of concrete. Grind or fill surfaces to produce level and plumb, true planes.

6. For walls exposed in the finish work, form tie holes shall be patched and finished flush with adjacent surface. For holes passing entirely through walls, use a plunger type injection gun or other suitable device shall be used to completely fill the holes.

7. In order to patch honeycombed areas or rock pockets which are too large and unsatisfactory for mortar patching, cut out to solid surface, key, and pack solid with matching concrete to produce firm bond and flush surface. Patching shall match texture of adjacent surfaces where exposed in the finished work.

8. Remove repair work in exposed locations which does not match the texture and color of surrounding adjacent surfaces or which was not well performed and perform again until the repair work conforms to specified requirements.

9. Remove fines and loose materials from surfaces to receive membrane waterproofing, and patch voids and cracks flush with adjacent surfaces.

10. Cure completed repairs as specified herein under Curing.

3.02 FINISHING OF FORMED SURFACES

A. Unexposed Surfaces:

1. Concrete which will not be exposed in the completed structure shall be any form finish as specified in Section 03100, Concrete Forming, and ACI 301 for rough form finish.

2. Concrete to receive membrane waterproofing shall receive a "smooth form finish" in accordance with ACI 301.

B. Exposed Surfaces: Unless indicated otherwise, concrete which will be exposed in the completed structure shall receive the following finishes as indicated:

1. Smooth Form Finish: Conform to ACI 301

2. Smooth Rubbed Finish: Conform to ACI 301

3. Grout Cleaned Finish: Conform to ACI 301

4. Unspecified Finish: When finish is not indicated, provide "smooth form finish" as specified above.

C. Sand Blast Finish:

1. Blasting Operations and Requirements:

a. Apply sandblasted finish to exposed concrete surfaces where indicated.

b. Perform sand blasting at least 72 hours after placement of concrete. Coordinate with formwork construction, concrete

placement schedule, and formwork removal to ensure that surfaces to be blast finished are blasted at the same age for uniform results.

c. Determine type of nozzle, nozzle pressure, and blasting techniques required to match the Engineer's control samples.

d. Abrasive blast corners and edge of patterns carefully, using back-up boards, to maintain uniform corner or edge line.

2. Depths of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surface to match the Engineer's control samples as follows:

a. Brush Sand Blast Finish: Remove cement matrix to expose face of fine aggregate; no reveal.

b. Light Sand Blast Finish: Expose fine aggregate with occasional exposure of coarse aggregate; maximum 1/16-inch reveal.

c. Medium Sand Blast Finish: Generally expose coarse aggregate; 3/16-inch to 1/4-inch reveal.

3. Surface Continuity: Perform sand blast finishing in one continuous operation, utilizing the same work crew to maintain continuity of finish on each surface or area of work. Maintain patterns of variances in depths of cuts as indicated.

4. Construction Joints: Use technique approved by the Engineer to achieve uniform treatment of construction joints.

5. Protection and Repair:

a. Protect adjacent materials and finishes from dust, dirt, and other surface or physical damage during abrasive blast finishing operations. Provide protection as required and remove from site at completion of the work.

b. Repair or replace other work damaged by finishing operations.

6. Clean-up: Maintain control of concrete chips, dust, and debris in each area of the work. Clean up and remove such material at the completion of each day of operation. Prevent migration of airborne materials by use of tarpaulins, wind breaks, and similar containing devices.

3.03 SLABS AND FLATWORK

A. Placement and Finishing Standards: Place, consolidate, and finish slabs and flatwork in accordance with applicable requirements of ACI 301. Coordinate with Section 03300, Cast-In-Place Concrete, as applicable.

B. Placement:

1. Place slabs and flatwork and finish monolithically. Strike off and screed slabs to true, plane surfaces at required elevations, and thoroughly compact concrete with vibrators, floats, and tampers to force coarse aggregate below the surface. Finish slab within four hours of concrete placement.

2. Whether indicated or not, in areas where drains occur, slope finished slab to drains. Slope shall be a minimum of 1/8-inch per foot unless otherwise indicated.

C. Slab Finishes: Unless indicated otherwise, slabs and flatwork shall receive the following finishes as indicated:

1. Scratched Finish: Conform to ACI 301. Provide "scratched finish" for slab substrates to receive cementitious toppings or finishes, such as terrazzo or mortar setting bed for ceramic tile.

2. Floated Finish: Conform to ACI 301. Provide "floated finish" for track slabs and mud slabs and for slabs and flatwork to receive roofing and membrane waterproofing.

3. Troweled Finish: Conform to ACI 301. Provide "troweled finish" for interior slabs and flatwork to be exposed in the completed structure, for slabs to receive resilient floor coverings, and for flatwork to receive elastomeric bearing pads.

4. Broom Finish: Conform to ACI 301. Exact texture and coarseness of the broom finish shall match the approved site mock-up. Provide fine or medium-coarse "broom finish" for exterior sidewalks and paving, garage floors (other than parking garages), exterior ramps, equipment and transformer pads, station platforms, and subway invert slab.

5. Unspecified Finish: When finish is not indicated or specified, provide finishes as specified in ACI 301.

6. Washed Aggregate Finish: Evenly distribute seeded aggregate over a floated finish. Tamp surface to bring fines to surface completely covering seeded aggregate. Apply troweled finish. Apply surface retarder according to manufacturer’s instructions and recommendations. Wash surfaces with water and finish with stiff bristle brush until seeded aggregate is uniformly exposed.

7. Swirl Pattern Finish: After basic floating operations have been completed, hand float slabs using wood float to produce a continuous swirl patterned surface, free from porous spots, irregularities, depressions, and small pockets or rough spots such as may be caused by accidentally disturbing particles of coarse aggregate embedded near the surface. Use natural arm circular motion to produce rows of approximately 1-foot radius swirl pattern covering approximately half of the preceding row with each successive row. Provide swirl pattern finish for parking garage floors.

D. Surface Tolerances and Finishes: Refer to Tolerances specified herein.

1. Flat Tolerance: Slabs and flatwork with "troweled finish" and with "nonslip finish."

2. Straightedge Tolerance: Slabs and flatwork with fine "broom finish" or medium-coarse "broom finish."

3. Bullfloated Tolerance: Slabs and flatwork with "scratched finish," with "floated finish," and with coarse "broom finish."

E. Joints:

1. Construction, expansion, isolation, and contraction joints shall be located as indicated. Construction joints shall act as contraction joints. Where additional contraction joints are required to prevent shrinkage cracks, saw-cut such joints. All joints shall be straight and true to line.

2. Mark-off lines or edges at formed construction and expansion joints shall be finished with 1/4-inch radius curved edging tool, neat and true to line, uniform throughout.

3.04 TOLERANCES

A. Formed Surfaces: Conform to applicable requirements of ACI 117.

1. Where elastomeric bearing pads are indicated, the level plane upon which bearing pads are placed shall not vary more than 1/16-inch from a 10-foot straightedge placed in any direction across the area and the area shall extend a minimum of 1 inch beyond the limits of the pads.

2. Bearing surfaces of girders on a slope or girders with a camber shall be finished on a horizontal/level plane so that loads are uniformly distributed over the entire surface of the elastomeric bearing pads.

3. The finished plane shall not vary more than 1/8-inch from the elevation indicated.

B. Slabs and Flatwork: Conform to applicable classification requirements of ACI 117, as follows:

1. Very Flat Tolerance: True plane with maximum variation of 1/8-inch in 10 feet when measured with a 10-foot straightedge placed anywhere on the slab in any direction.

2. Flat Tolerance: True plane with maximum variation of 3/16-inch in 10 feet when measured with a 10-foot straightedge placed anywhere on the slab in any direction.

3. Straightedge Tolerance: True plane with maximum variation of 5/16-inch in 10 feet when measured with a 10-foot straightedge placed anywhere on the slab in any direction.

4. Bullfloated Tolerance: True plane with maximum variation of 1/2 inch in 10 feet when measured with a 10-foot straightedge placed anywhere on the slab in any direction.

3.05 CURING

A. Curing Standards: Cure concrete in accordance with applicable requirements of ACI 301 and ACI 308, except that the duration of the curing period shall be ten days. Curing of concrete shall also conform to Section 03300, Cast in Place Concrete.

B. Curing Requirements:

1. Cure concrete with waterproof sheet materials, damp burlap, or curing compounds.

2. Do not use curing compounds on surfaces when their use may be detrimental to bonding of concrete, mortar, membrane waterproofing, calking and sealants, adhesives, plaster, paint, or the specified surface finish or coating.

3. Cure color-hardener finished slabs and flatwork as recommended by the color-hardener material manufacturer.

4. Cure integrally colored concrete as specified in Section 03160, Colored Concrete, and as specified herein.

5. At the expiration of the curing period, clean concrete surfaces of all curing media.

C. Damp Curing:

1. Vertical surfaces shall be cured by keeping the forms wet at all times and by leaving the forms in place as specified in Section 03100, Concrete Forming. After removal of forms, concrete shall be kept continuously damp by fog spraying or otherwise washing down the concrete in an accepted manner until ten days after placing. Protect exposed surfaces by covering with sheet materials or burlap kept continuously moist.

2. Horizontal surfaces shall be cured and protected by covering the finished surfaces with waterproof sheet materials or damp burlap, left in place for a minimum of ten days and kept continuously moist.

3. Fog spray freshly placed slabs until finishing operations commence. Allow no slabs to become dry until finishing operations are complete.

D. Curing Compound: Non-structural concrete, such as slabs-on-grade, may be cured by membrane curing compound in lieu of wet curing specified above. Apply curing compound in accordance with applicable requirements of ACI 308 and manufacturer's instructions. Apply without delay on newly finished surface. Protect integrity of membrane and touch up damaged spots immediately.

3.06 PROTECTION

A. Protect exposed concrete surfaces, including flatwork, as required to prevent damage from impact or strains.

B. Protect fresh concrete from drying winds, rain, damage, or soiling.

C. Refer to Section 03300, Cast-In-Place Concrete, for additional requirements.

D. Prevent contamination of planting areas during washing of washed aggregate finish.

END OF SECTION

SECTION 03200
CONCRETE REINFORCING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for concrete reinforcing.

1.02 REFERENCE STANDARDS

A. American Concrete Institute (ACI):

1. 301-20 Specifications for Concrete Construction.

2. 315-18 Guide to Presenting Reinforcing Steel Design Details.

B. ASTM International (ASTM):

1. A1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

2. A706 Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement

3. A767 Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement

4. A775 Standard Specification for Epoxy-Coated Reinforcing Steel Bars

5. A884 Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement

6. C1107 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

7. D3963 Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars

C. American Welding Society (AWS):

1. D1.4 Structural Welding Code – Reinforcing Steel

2. QC-1 Specification for AWS Certification of Welding Inspectors

D. Concrete Reinforcing Steel Institute (CRSI):

1. Manual of Standard Practice

2. Placing Reinforcing Bars

E. State of California, Department of Transportation, Standard Specifications (Caltrans):

1. Section 52 Reinforcement

2. Section 83 Railings and Barriers

3. Section 90 Concrete

F. State of California, Department of Transportation, Test Methods (CTM):

1. 417 Method of Test for Soils, Concrete Patching Materials and Waters for Sulfate Content

2. 422 Method of Test for Soils, Concrete Patching Materials and Waters for Chloride Content

G. American Society for Nondestructive Testing (ASNT)

1. SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing

1.03 SUBMITTALS

A. Reinforcing Steel Shop Drawings: Indicate sizes, spacing, bending and cutting schedules, splices and laps, supporting and spacing devices, and quantities. Coordinate drawings to prevent reinforcing steel from interfering with the placement of embedded items.

B. Submit manufacturer's product data and installation instructions for proprietary mechanical coupler systems when such splicing methods are permitted.

C. Qualifications of welding operators, welding processes, and procedures. For welders, furnish welding certificates or affidavits attesting to the welders' qualifications to perform the indicated welding in accordance with applicable requirements of AWS D1.4.

1.04 DELIVERABLES

A. Submit copies of inspection and test reports for welding as required in this Section.

B. Certificates of Compliance: Submit a certificate of compliance for each shipment of reinforcement. For galvanized reinforcing bars, submit certificates of compliance with ASTM A767.

C. Mill Test Reports: Submit certified mill test reports (tensile and bending) for each heat or melt of steel showing physical and chemical analyses before delivery of reinforcing material to the job site.

D. When galvanized or epoxy-coated reinforcing bars are indicated, furnish two 12-inch long samples and two additional samples bent to minimum radius of the rebar from each lot shipped to the work site.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with the requirements of applicable building codes, CRSI Manual of Standard Practice, and CRSI Placing Reinforcing Bars.

B. Perform work in accordance with the requirements of ACI 301 and ACI 315.

C. Qualifications of Welding Inspector: Welds to be inspected by the Contractor shall be inspected and certified by a Contractor-employed AWS Certified Welding Inspector (CWI), certified in accordance with AWS QC 1.

D. Qualification of Personnel Performing Nondestructive Testing: Personnel performing nondestructive testing, who are Contractor-employed, shall be qualified and certified in accordance with ASNT SNT-TC-1A. Only persons certified for NDT Level I and working under a NDT Level II person or persons certified for NDT Level II may perform nondestructive testing.

Contractor shall perform ultimate splice testing and submit the results per requirements in Caltrans Standard Specification Section 52-6 Splicing.

1.06 DELIVERY, STORAGE AND HANDLING

A. Ship and store reinforcement with bars of the same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same designations as shown on the submitted placing drawings.

B. Store reinforcement off the ground, protect from moisture, and keep free from dirt, oil, or other contaminants. Steel, which cannot be properly identified, will be rejected and shall be immediately removed from the work site.

C. Handle and store galvanized and epoxy-coated reinforcement in a manner which will prevent damage to the coatings. For epoxy-coated reinforcement, comply with the requirements of ASTM D 3963.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Reinforcing Steel Bars: ASTM A706

B. Reinforcing Steel Wire: ASTM A 82, cold drawn

C. Welded Steel Wire Fabric – Plain Wire: ASTM A 185, uncoated finish

D. Welded Steel Wire Fabric – Deformed Wire: ASTM A 497, uncoated finish

E. Welded Steel Wire Fabric – Epoxy-Coated: ASTM A 884

F. Epoxy-coated Reinforcing Bars: ASTM A 706 epoxy-coated in accordance with ASTM A 775 and ASTM D 3963. Coating material shall conform to ASTM A 775 and ASTM D 3963, Annex 1, green in color. Bars shall be cut and bent cold before applying coating material.

G. Galvanized Reinforcing Bars: ASTM A 706 galvanized in accordance with ASTM A 767, Class I coating. Bars shall be cut and bent cold before galvanizing.

H. Mechanical Splice Coupler: Provide bar splicing connections produced by threaded reinforcing bar ends and threaded coupler, or by sleeves hydraulically pressed or forged onto butt-ended reinforcing bars. Mechanical splice couplers shall be capable of being installed in the clear space indicated and to provide the required clearances. The strength of the splice in tension and compression shall be a minimum of 125 percent of the yield strength of the connected reinforcing bars.

I. Welding Electrodes: E90 meeting the requirements of AWS D1.4.

J. Ultimate splices shall conform to the requirements in Caltrans Standard Specification Section 52-6 Splicing.

2.02 ACCESSORIES

A. Steel Tie Wire: No. 16 gage or heavier, black or galvanized, soft or commercial grade steel tie wire. For galvanized reinforcement, provide zinc-coated wire. For epoxy-coated reinforcement, provide nylon-, epoxy-, or plastic-coated wire.

B. Chairs, bolsters, bar supports, and spacers:

1. Metal, plastic tipped, in accordance with the requirements of CRSI Manual of Standard Practice for reinforced concrete construction.

2. Sized and shaped for strength and support of reinforcement during installation and placement of concrete.

3. For galvanized reinforcement, provide all galvanized accessories.

4. For epoxy-coated reinforcement, provide accessories which are nylon-, epoxy-, or plastic-coated.

2.03 GROUT

A. Bonding Material for Bonding Dowels: As specified in Caltrans Standard Specifications, Section 51-1.03E, Miscellaneous Construction.

B. Non-Shrink Grout: Grout shall be a premixed package blend of Portland cement, graded silica sand, and water reducing, plasticizing and time release expansion agents, which conforms to ASTM C1107, Grade B, and provides a minimum 5000 psi compressive strength at 28 days. Mix grout in accordance with the manufacturer's recommendations. Water shall comply with the provisions in Caltrans Standard Specifications, Section 90-1.02D, Water.

1. Admixtures shall not contain more than 0.05 percent soluble chlorides when tested in conformance with California Test 422, nor more than 0.25 percent soluble sulfates, as SO_4, when tested in conformance with California Test 417.

2.04 FABRICATION

A. Fabricate in accordance with the requirements of ACI 315.

B. Locate splices not indicated on the Contract Drawings at point of minimum stress.

C. Repair of Damaged Coatings:

1. Epoxy: Repair in accordance with the provisions in Caltrans Standard Specifications, Section 52, Reinforcement.

2. Galvanized: Repair as specified in ACI 301, ASTM A 767, ASTM A 775, ASTM A 884, and ASTM D 3963, as applicable.

D. Welding:

1. Welding of reinforcement, where indicated and approved, including preparation of bars, shall conform with applicable requirements of AWS D1.4.

2. Clean bars of oil, grease, dirt, and other foreign matter and flame-dry before welding. Preheat bars for welding in accordance with AWS D1.4, Chapter 5.

3. Butt Welded Splices: Use full penetration butt welds in accordance with the provisions in Caltrans Standard Specifications, Section 52, Reinforcement, unless another weld splice type is indicated or approved.

PART 3 - EXECUTION

3.01 PREPARATION

A. Before placing concrete, clean reinforcement of foreign particles, including mortar, oil, grease, dirt, loose mill scale, rust and any other coating that will prevent or reduce bond.

B. Place in position, support, and secure reinforcement to prevent displacement during concrete placement. Do not deviate from alignment or spacing as shown on the Contract Drawings.

3.02 CLEANING, BENDING, PLACING, AND SPLICES

A. Perform work in accordance with the provisions in Caltrans Standard Specifications, Section 52, Reinforcement, and as specified herein.

B. Perform installation of mechanical coupler and tightening for joint assembly in accordance with the coupler manufacturer's installation instructions and recommendations.

3.03 DRILLING AND BONDING DOWELS

A. Drilling and bonding dowels shall conform to the details shown on the Contract Drawings, the provisions in Caltrans Standard Specifications, Section 51-1.03E(3), Drill and Bond Dowels, and as specified herein.

B. If reinforcement is encountered during drilling, before the specified depth is attained, notify the Engineer. Unless the Engineer approves coring through the reinforcement, the hole will be rejected. If hole is rejected, drill a new hole, in which reinforcement is not encountered, adjacent to the rejected hole to the depth shown on the Contract Drawings. Grout rejected hole.

C. Dowels shall conform to the provisions for reinforcing steel bars specified herein.

3.04 DRILLING AND GROUTING DOWELS

A. Drilling and grouting dowels shall consist of drilling through reinforced concrete bridge members, placing reinforcement and filling holes with non-shrink grout, and shall conform to the details shown on the Contract Drawings, the provisions in Caltrans Standard Specifications, Section 51-1.03E(4), Drill and Grout Dowels, and as specified herein.

B. If reinforcement is encountered during drilling, before the specified depth is attained, notify Engineer. Unless the Engineer approves coring through the reinforcement, the hole will be rejected. If hole is rejected, drill new hole, in which reinforcement is not encountered, adjacent to the rejected hole to the depth shown on the Contract Drawings. Grout rejected hole.

C. Dowels shall conform to the provisions for reinforcing steel bars specified herein.

D. Clean concrete areas to be in contact with grout of all loose or foreign material that would in any way prevent bond between the concrete surfaces, flush flushed with water, and allow to dry to a surface dry condition immediately prior to grouting.

E. After placement of reinforcement, seal ends of the drilled hole containing the reinforcement, with one vent tube and one injection feed tube. Place tubes in the hole in a manner which will allow the air to vent and the hole to be completely filled with grout. Achieve sufficient pressure to ensure that the hole is free of voids. Pump grout through the holes and continually waste grout until no visible slugs or other visible evidence of water or air are ejected and the efflux time of ejected grout is not less than 11 seconds.

F. Prevent grout from falling into any waterway and on public traffic, from flowing across shoulders or lanes occupied by public traffic, and from flowing into gutters or other drainage facilities.

3.05 FIELD QUALITY CONTROL

A. Inspection and testing of welds shall be performed by an approved Inspection and Testing Agency retained by the Contractor:

1. Visually inspect reinforcing bar welds.

2. Tension tests of welded butt joints shall be performed on sample welds produced by the Contractor in accordance with ASTM E8.

3. Nondestructive tests of installed welded butt joints shall be performed in accordance with ASTM E165.

4. Inspections and tests shall be performed in accordance with the applicable requirements of AWS D1.4, Chapters 6 and 7.

5. Perform ultimate splice testing per the requirements of the Caltrans Standard Specifications Section 52-6 Splicing.

END OF SECTION

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section includes specifications for cast-in-place Portland cement concrete including mix designs, delivering, and placing.

1.02 REFERENCE STANDARDS

A. American Concrete Institute (ACI):

1. 211.1 Selecting Proportions for Normal-Density and High Density-Concrete Guide
2. 301 Specifications for Concrete Construction
3. 302.1R Guide to Concrete Floor and Slab Construction
4. 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete
5. 305R Guide to Hot Weather Concreting
6. 306.1 Standard Specification for Cold Weather Concreting
7. 308R Guide to External Curing of Concrete
8. 318 Building Code Requirements for Structural Concrete

B. ASTM International (ASTM):

1. C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field
2. C33 Standard Specification for Concrete Aggregates
3. C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
4. C94 Standard Specification for Ready-Mixed Concrete
5. C109 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens)
6. C138 Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
7. C143 Standard Test Method for Slump of Hydraulic-Cement Concrete
8. C150 Standard Specification for Portland Cement

9. C171 Standard Specification for Sheet Materials for Curing Concrete

10. C173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

11. C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

12. C260 Standard Specification for Air-Entraining Admixtures for Concrete

13. C494 Standard Specification for Chemical Admixtures for Concrete

14. C579 Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes

15. C618 Standard Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

16. C827 Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures

17. C928 Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs

18. C1107 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

19. C1059 Standard Specification for Latex Agents for Bonding Fresh To Hardened Concrete

20. C1116 Standard Specification for Fiber-Reinforced Concrete

21. C1582 Standard Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete

22. D1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

23. E329 Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

C. State of California, Department of Transportation, Standard Specifications, (Caltrans):

1. Section 51 Concrete Structures

2. Section 90 1.01D(5)(b) Concrete Compressive Strength Prequalification

D. U.S. Army Corps of Engineers, Concrete Research Division (CRD):

1. C621 Specification for Non-Shrink Grout

1.03 SUBMITTALS

A. Concrete Mix Designs: Submit mix designs for each class of concrete, including color concrete mixes. Indicate locations to be used. Include names and brands of materials, proportions, slump, strength and gradation of aggregates. Include laboratory test reports of trial strength and shrinkage tests.

B. Product Data: Submit manufacturer's product data for proposed products, including epoxy adhesive, grout, and concrete admixtures.

C. Shop Drawings:

1. Submit drawings that indicate the locations of all joints in concrete, including construction joints, expansion joints, isolation joints, and contraction joints. Coordinate with the requirements specified in Section 03100, Concrete Forming.

2. Submit drawings that indicate concrete placement schedule, method, sequence, location, and boundaries. Include each type and class of concrete, and quantity in cubic yards.

3. Submit drawings that detail the type, size, and location of all pipes, conduit, embeds, blockouts, and recesses for all vertical and horizontal concrete construction.

4. Reproductions of contract drawings are unacceptable.

D. Submit for the Engineer’s approval the name, address, and telephone number of the laboratory, agency, mill, or ready-mix plant which the Contractor intends to engage to design the concrete mixes.

1.04 DELIVERABLES

A. Certificates of Compliance: For each shipment of materials, submit evidence of compliance with Specification requirements for cement, aggregate and admixtures.

B. Batch Tickets: Submit a delivery ticket with each batch of concrete delivered to the site in accordance with the requirements of ASTM C94.

C. Records and Reports: Report the location in the finished work of each mix design, and the start and completion times of placement of each batch of concrete placed for each date concrete is placed.

1.05 QUALITY ASSURANCE

A. Qualifications of Mix Design Source: Obtain mix designs, including recommended amounts of admixture and water to be used in the mixes, from a qualified independent testing laboratory or agency, or from a mill or ready-mix plant, properly equipped to design concrete mixes. The laboratory, agency, mill, or ready-mix plant shall meet applicable requirements of ASTM E329.

B. Comply with ACI 304R.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Concrete Materials:

1. Portland Cement: Conforming to ASTM C150 Type I or II

2. Air-entraining admixture: Conforming to ASTM C260

3. Fine aggregate: Conforming to ASTM C33

4. Coarse aggregate: Conforming to ASTM C33

5. Water: Potable, clear and free of injurious amounts of oil, acid, alkali, salts, organic matter, and any other substances that may be deleterious to concrete or steel.

6. Corrosion inhibitor: Products that conform to ASTM C1582 such as:

   a. DCI by Grace Concrete Products

   b. Rheocrete 222 by Master Builders, Inc.

B. Optional Concrete Admixtures and Cementitious Materials: At Contractor's option and with Engineer's acceptance, include accepted concrete admixtures and cementitious materials in the mix to improve the water-cement ratio or water-cementitious ratio or workability of the concrete, providing strengths specified and other desirable characteristics of the concrete can be achieved and maintained. Obtain Engineer's acceptance of proposed admixtures prior to use. Indicate admixtures in design mix. Add admixtures at batch plant and add in solution form, except as otherwise approved.

1. Chemical Admixtures, Water-Reducing: ASTM C494, Type A

2. Pozzolanic Admixtures: ASTM C618, Class N or F

3. Fly Ash: ASTM C618, Class F, with a maximum of 25 percent retained on the No. 325 mesh sieve and a loss on ignition of 1.0 percent maximum.

4. Pigments for integrally colored concrete: Refer to Section 03160, Colored Concrete.

5. Chemical Admixtures, Plasticizing: ASTM C1017, or ASTM C494 Type F or Type G, high-range water-reducing admixtures.

6. Prohibited Admixtures: Admixtures containing chlorides or sulfides are not acceptable.

C. Grout:

1. Cementitious Grout: Provide a prepackaged, nonshrink, nonmetallic, noncorrosive cement-based grout conforming to the following requirements:

    a. ASTM C1107: Grout shall be manufactured specifically for use in supporting heavy loads and shall have a minimum compressive strength of 7,500 psi at 28 days.

    b. Shrinkage at 28 days: No shrinkage before hardening (0.00 shrinkage when tested in accordance with ASTM C827); no shrinkage after hardening (0.00 shrinkage when tested in accordance with CRD-C621.)

2. Epoxy Grout: Provide a nonshrink, nonmetallic, noncorrosive epoxy grout conforming to the following requirements:

    a. Grout shall be a 3-component epoxy resin system (two liquid epoxy components and one inert aggregate filler component) manufactured specifically for use in supporting heavy loads. The minimum compressive strength shall be 10,000 psi at seven days when tested in accordance with ASTM C579.

    b. Shrinkage at 28 days: None (0.00 shrinkage when tested in accordance with ASTM C827 modified procedure) with a minimum bearing area (EBA) of 95 percent coverage of the tested base plate.

3. Cementitious Grout for Repairs to Concrete Pavements and Structures: Provide a prepackaged, nonshrink, nonmetallic, noncorrosive cement-based grout conforming to the following requirements:

    a. ASTM C928. Compressive strength of 5000 psi minimum in 7 days, conforming to ASTM C109.

    b. Rapid-hardening when mixed with water, forming a permanent bond. Initial set shall be in 30 minutes.

D. Expansion Joint Filler: Pre-molded asphalt impregnated felt conforming to ASTM D1751, 1/2-inch unless otherwise indicated on the Contract Drawings.

E. Polypropylene Fibers:

1. Fibrillated Polypropylene Fibers: 100 percent virgin polypropylene, MD Graded, containing no reprocessed olefin materials, and specifically manufactured for use as concrete secondary reinforcement, and to protect concrete from stresses which cause cracking initially after placement.

2. Monofilament Polypropylene Fibers: 100 percent virgin polypropylene, MD Graded, containing no reprocessed olefin materials, and specifically manufactured to protect concrete from stresses which cause cracking initially after placement.

3. The physical characteristics of the polypropylene fibers shall be as follows:

a. 1/2 inch or 3/4 inch polypropylene fibers, maximum 3 denier, complying with ASTM C1116, Type III.

b. Not less than 50 million individual fibers per pound.

4. Supply fibers in cellulose fiber bags which disintegrate and disperse fibers during mixing. Other packaging and dispensing means may be acceptable.

F. Bonding Agent: ASTM C1059 for bonding fresh to hardened concrete.

G. Curing Materials: Refer to Section 03170, Concrete Finishing.

H. Expanded Polystyrene: As specified in the Caltrans Standard Specifications, Section 51- 2.01B(1).

2.02 MIX CRITERIA

A. Ready-mix concrete shall conform to ASTM C94, Option B. Proportions shall conform to ACI 211.1, except as modified below.

B. Concrete shall comply with ACI 301 and ACI 318, as applicable. Ensure that mix designs will produce concrete suited for proper placement and finishing.

C. Concrete mix:

1. Compressive strength: 4,000 psi minimum at 28 days, unless otherwise indicated on the Contract Drawings.

2. Corrosion inhibitor added in accordance with the manufacturer's instructions; 2 gallons DCI or 1 gallon Rheocrete 222 per cubic yard of concrete, minimum. Add corrosion inhibitor to concrete mix where groundwater is encountered during construction and as directed by the Engineer.

3. Include polypropylene fibers in concrete mix for station platform finish pour, and for locations as indicated in the Contract Documents. For uniform distribution, mix in truck for a minimum of 20 minutes after fiber addition. Add fibers at the batch plant to ensure proper mixing. Use the following dosages:

a. Typical: One pound per cubic yard of concrete unless greater dosage is recommended by the fiber manufacturer.

b. Bus Access Lanes and Bus Stop Pads: One and one half pounds per cubic yard.

4. Design concrete mix for pumping to meet requirements specified herein except that mix may be richer in lubricating components in order to allow proper pumping, subject to the Engineer’s approval.

D. Each trial mix shall be developed by an independent testing laboratory in accordance with the requirements of ACI 318 and ACI 301. Quality control relating to mix design shall be provided by the Contractor.

2.03 SOURCE QUALITY CONTROL

A. The Contractor shall perform testing of concrete ingredients at their source of supply using a Contractor-hired independent testing laboratory.

PART 3 - EXECUTION

3.01 PREPARATION

A. Inspect forms, earth bearing surfaces, reinforcement, and embedded items, and obtain the Engineer's written approval before placing concrete.

B. Verify that substrates are in suitable condition to receive the work of this Section. Correct unsuitable conditions prior to proceeding.

C. Earth bottoms or bearing surfaces for footings and slabs shall be dampened but not saturated or muddied just prior to placing concrete.

3.02 PLACEMENT

A. Convey and place concrete in compliance with the applicable requirements of ACI 301, ACI 302.1R, ACI 304R, and ACI 318.

B. Place no concrete until reinforcing is fastened in place and forms are complete. Place no concrete before work that is to be embedded has been correctly set and secured. Do not disturb reinforcing or other materials that have been set in place.

C. Conform to the requirements of ACI 318. Remove debris, mud and water from surfaces to receive concrete. Clean surfaces of forms and embedded items of all mortar, grout and deleterious materials before placing concrete. Place concrete in dry formwork and prevent water from entering or lying in formwork where concrete is being placed or is setting.

D. Place concrete immediately after mixing. Do not use concrete after it has begun to stiffen. Do not retemper concrete by adding water in the field. If chuting is used, prevent segregation. Concrete at time of placing shall have 4 inches slump maximum, unless otherwise specified or approved with mix design, and temperature of 50 to 90 degrees F. Concrete with temperature exceeding 90°F at time of placement will be rejected and shall be removed from the job site.

E. Minimum Concrete Cover (Unless otherwise indicated on the Contract Drawings):

1. Concrete deposited against ground: 3 inches

2. Formed surfaces exposed to weather: 2 inches

3. Slab-on-grade with one layer of reinforcement: Centered

F. Conform to ACI 305R and 306.1 for placement of concrete in hot and cold weather, respectively.

G. Transfer concrete from mixer to point of placement as rapidly as practical preventing formation of cold joints. Use equipment and methods that permit rapid placing of concrete of the required consistency and prevent segregation.

1. Convey concrete with conveyors, pipes, chutes, or spouts to a point not more than 3 feet from its final position.

2. Do not change material proportions or consistency of the concrete to accommodate mixing and placing.

3. Use no pipes, chutes or other equipment made of aluminum.

H. Regulate air entrainment and slump within specified limits.

I. Deposit concrete vertically in forms as nearly as practical in its final position, in approximately horizontal layers.

J. Pumping: Concrete may be placed by pumping where approved by the Engineer.

1. Use equipment for pumping of such size and design as to ensure a practically continuous flow of concrete at the delivery end without separation of materials. Pump shall be piston or squeeze pressure type. Pipeline shall be steel pipe or heavy-duty flexible hose. Inside diameter of the pipe shall be at least three times the maximum size of the coarse aggregate. Distance to be pumped shall not exceed the limits recommended by pump manufacturer. Supply concrete continuously to the pump. When pumping is completed, eject the concrete remaining in the pipeline without contaminating the concrete in place. After each operation, thoroughly clean equipment. Waste flushing water outside the forms in compliance with storm water pollution prevention requirements specified in Section 01560, Temporary Controls.

2. Do not pump concrete through aluminum pipes.

3. Provide full-time inspection of all pumping operations by a recognized testing laboratory approved by the Engineer.

K. Avoid formation of laitance and accumulation of excessive water on surface of concrete as it is deposited. Remove accumulated water before placing additional concrete.

3.03 CONSTRUCTION JOINTS

A. Construction joints will be permitted only where indicated or approved by the Engineer.

B. Make construction joints straight and as inconspicuous as possible, and in exact vertical and horizontal alignment with the structure.

C. Locate joints which are not indicated so that the strength of the structure is not impaired and where shown on approved shop drawings.

D. Provide and prepare construction joints and install waterstops in accordance with the applicable requirements of ACI 301 and ACI 304R, and as specified in Section 03100, Concrete Forming.

E. Use an ACI approved key, at least 1-1/2 inches in depth, at joints unless otherwise indicated or approved by the Engineer.

F. Thoroughly clean the surface of the concrete at construction joints and remove laitance, loose or defective concrete, coatings, sand, sealing compound and other foreign material. Prepare surfaces of joints by sandblasting or other approved methods to remove laitance and expose aggregate uniformly.

G. Immediately before new concrete is placed, wet the joint surfaces and remove standing water. To allow for shrinkage, do not place new concrete against the hardened concrete side of a construction joint for a minimum of 72 hours.

H. Ensure that reinforcement is continuous across construction joints.

I. Where bonding of the joint is required, provide bonding agent.

J. Retighten forms and dampen concrete surfaces before concrete placing is continued.

K. Allow at least 72 hours to elapse before continuing concrete placement at a construction joint. Acceptance for accelerating the minimum time elapsing between adjacent placements will be based on tests and methods which confirm that a minimum moisture loss at a relatively constant temperature will be maintained for the period as necessary to control the heat of hydration and hardening of concrete, and to prevent shrinkage and thermal cracking.

3.04 CONSOLIDATION AND FINISHING

A. Thoroughly work concrete into all corners and around all embedded items and into corners and shapes of formwork, leaving no excessive voids in the concrete or honeycombed surfaces.

B. Consolidate concrete with a mechanical vibrator of type and size acceptable to the Engineer. Vibrators shall be operated in such a manner as to reach all concrete areas, but minimize the amount of contact with reinforcing steel and formwork.

C. All concrete shall be fully consolidated within 15 minutes of placement.

D. Obtain a uniform surface by floating as necessary. Concrete surface shall be within 1/4 inch laterally and 1/8 inch vertically from specified line and grade, except where stricter tolerances are indicated.

E. Apply a uniform broomed finish to the concrete surface for exterior sidewalks, paving, exterior ramps, station platforms, and equipment pads unless indicated otherwise. Broom marks shall not exceed 1/8 inch in depth. Exact texture and coarseness of the broom finish shall match the approved site mock-up.

F. Tool all edges with a 2-inch wide, 1/4-inch radius rounded edger.

G. Refer to Section 03170, Concrete Finishing, for additional finishing requirements.

3.05 CURING AND PROTECTION

A. Curing of concrete shall conform to applicable requirements of ACI 301 and ACI 308, except that the curing duration shall be a minimum period of ten days. Curing with earth, sand, sawdust, straw, and hay will not be permitted.

B. Keep concrete in a moist condition from the time it is placed until it has cured for at least ten days. Keep forms damp and cool until removal of forms.

C. Immediately upon removal of forms, exposed concrete surfaces shall be kept moist by applying an approved curing compound or by covering with damp curing materials as specified in Section 03170, Concrete Finishing.

D. Do not permit concrete to dry during the curing period because of finishing operations.

E. Protect fresh concrete from hot sun, drying winds, rain, damage, or soiling. Fog spray freshly placed slabs after bleed water dissipates and after finishing operations commence. Allow no slabs to become dry at any time until finishing operations are complete.

F. Finishing and curing of slabs are specified in Section 03170, Concrete Finishing.

G. Protect concrete from injurious action of the elements and defacement of any kind. Protect exposed concrete corners from traffic or use which will damage them in any way.

H. Protect concrete during the curing period from mechanical and physical stresses which may be caused by heavy equipment movement, subjecting the concrete to load stress, load shock, or excessive vibration.

I. Fog Spray: Keep the entire surface of concrete damp by applying water with a nozzle that so atomizes the flow that a mist and not a spray is formed, until the surface of the concrete is covered with a curing medium. The moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface.

J. Maintain a minimum temperature of 50 degrees F in the concrete for not less than 6 days for concrete subject to loads.

3.06 GROUT

A. Surface Preparation:

1. Concrete surfaces to receive grout shall be prepared by chipping, water blasting, or other accepted methods to remove defective concrete, laitance, dirt, oil, grease, and other foreign matter to achieve sound, clean

concrete surfaces. Lightly roughen concrete for bond, but not to interfere with proper placement of grout.

2. Cementitious Grout: Saturate concrete surfaces with clean water for 24 hours prior to grouting and remove excess water immediately before grouting.

3. Epoxy Grout: Apply only to a clean, dry, roughened, sound concrete surface.

B. Mixing:

1. Mix grout ingredients for both cementitious and epoxy grout in accordance with the respective manufacturer's mixing instructions and recommendations. Mix grout materials in proper mechanical mixers.

2. Mix grout as close to work area as possible.

C. Placing:

1. Cementitious Grout:

a. Place in accordance with manufacturer's instructions.

b. Completely fill all spaces and cavities below the bottom of baseplates.

c. Provide forms where baseplates and bedplates do not confine grout.

d. Where exposed to view, finish grout edges smooth. Taper edges at an angle of 60 degrees when measured from the horizontal, or as indicated on the Contract Drawings.

e. Protect against rapid moisture loss by covering with wet rags or polyethylene sheets.

f. Wet cure grout for seven days, minimum.

2. Epoxy Grout:

a. Place in accordance with manufacturer's instructions.

b. Completely fill all spaces and cavities around dowels and anchors without voids.

c. Obtain manufacturer's field technical assistance as required to ensure proper placement.

d. Cure grout as recommended by the manufacturer.

3.07 FIELD QUALITY CONTROL

A. The Contractor will perform field testing listed herein by use of a Contractor-hired independent testing laboratory. The Contractor will determine test locations as approved by the Engineer. Test results shall be submitted to the Engineer.

1. At least one set of three cylinders made in accordance with ASTM C31 and cured under laboratory conditions for each day of placing concrete or grout.

2. At least one slump testing in accordance with ASTM C143 and air content test in accordance with ASTM C138, C173, or C231 made for each day of placing concrete or grout.

3. The three concrete cylinders will be broken after 28 days to determine the compressive strength of the concrete. Compressive strength will be tested in accordance with ASTM C39.

4. The one grout cylinder will be broken after 7 days, and two grout cylinders will be broken after 28 days to determine the compressive strength of the grout. Compressive strength will be tested in accordance with ASTM C39.

B. If the average compressive strength of any set of three concrete cylinders, or any set of two grout cylinders broken at 28 days, does not achieve the specified amount, the Engineer may require the Contractor to do one or more of the following, at the Contractor's expense:

1. Additional field testing by coring or impact hammer to determine if in-place compressive strength meets specified requirement. The Contractor shall repair all core holes as approved by the Engineer.

2. Removal and replacement of work.

3. Other procedures determined by the Engineer.

3.08 CRACK INTENSITY

A. The Engineer will measure crack intensity of new cast-in-place concrete deck surfaces after curing and removal of forms. The Contractor shall clean the deck surface for the Engineer to measure surface crack intensity.

B. In any 100 sq ft portion of new deck surface, if there are more than 10 feet of cracks having a width at any point of over 0.02 inch, the Contractor shall treat the deck with methacrylate resin under Caltrans Standard Specification Section 60-3.03B. The Contractor shall treat the entire deck width to 5 feet beyond where the furthest continuous crack emanating from the 100 sq ft section is 0.02 wide.

END OF SECTION

SECTION 03310
CELLULAR CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide homogenous cellular concrete at the locations shown in the Contract Drawings, as specified herein, and as required for a complete and proper installation.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM)

1. C33 Standard Specification for Concrete Aggregates
2. C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
3. C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
4. C88 Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
5. C117 Standard Test Method for Materials Finer than 75μm-(No. 200) Sieve in Mineral Aggregates by Washing
6. C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
7. C150 Standard Specification for Portland Cement
8. C495 Standard Test Method for Compressive Strength of Lightweight Insulating Concrete
9. C595 Standard Specification for Blended Hydraulic Cements
10. C796 Standard Test Method for Foaming Agents for Use in Producing Cellular Concrete Using Preformed Foam
11. C869 Standard Specification for Foaming Agents Used in Making Preformed Foam for Cellular Concrete
12. C1157 Standard Performance Specification for Hydraulic Cement

1.03 QUALITY CONTROL/QUALITY ASSURANCE

A. Quality Control Plan. The Contractor shall submit a Quality Control Plan, conforming to the requirements of Section 01400 Quality Control and

Assurance, covering all operations and the field quality control to be performed by the Contractor.

B. Logs. The Contractor shall provide the Engineer with installation logs within 24 hours of the end of each work shift.

C. The specialized batching, mixing, and placing equipment shall be automated with bulk handling equipment approved by the manufacturer. Transit mixers will not be permitted for these applications.

1.04 SUBMITTALS

A. General: Submit shop drawings conforming to Section 01300 Submittals and Deliverables.

B. Product Data. The Contractor shall submit test reports confirming the cellular concrete material properties as specified herein.

C. Personnel Requirements:

1. The Contractor shall submit detailed resumes of experience of the listed Contractor's on-site representatives, including installation operator and installation supervisor. Submit name(s), address(es), and telephone numbers of person(s) who can verify the representative's work experience. The Contractor's on-site representatives shall have at least two (2) years' gainful employment with the firm performing the work to assure the full and competent knowledge of the Contractor's equipment, personnel, procedures, etc.

2. Submit resumes for the proposed installation supervisor demonstrating a minimum of five (5) years' experience in applying Cellular Concrete Fill and work experience on at least two (2) projects with installation of Cellular Concrete Fill. Submit resume for the proposed operator demonstrating a minimum of three (3) years of construction experience with at least one (1) year of work with Cellular Concrete Fill and one (1) year of operating with the Contractor's proposed equipment.

D. Equipment Description. The Contractor shall submit complete descriptions and operating information for equipment intended to perform the specified work.

E. Cellular Concrete Installation Procedures. The Contractor shall submit the cellular concrete installation procedures as specified in Part 3 - Execution.

F. Work Plan. Contractor is to submit a work plan which shall include: the contractor's proposed lift thickness, the maximum slope of a pour surface, and a detailed safety plan for placement of cellular concrete.

G. Quality Control Plan. Contractor is to submit a quality control plan as described in Section 1.03.

PART 2 – PRODUCTS

2.01 EXPANSION MATERIAL

A. The expansion material shall conform to ASTM C 869, and be approved in advance by the Engineer to produce cellular concrete meeting the properties of Article 2.05, herein.

2.02 CEMENT

A. Portland cement shall comply with ASTM C150, C595, or C1157. Pozzolans and other cementitious materials may be used.

2.03 WATER

A. Water shall be potable, clear and free of injurious amounts of oil, acid, alkali, salts, organic matter, and any other substances that may be deleterious to concrete or steel per Section 03300 Cast-In-Place Concrete.

2.04 ADMIXTURES

A. Admixtures may be used when specifically approved by the Engineer and the manufacturer of the cellular concrete.

2.05 PROPERTIES

A. The cellular concrete shall meet the following:

	Class II	Class IV
Cast Density	25 pcf - 30 pcf	39 pcf - 42 pcf
Minimum Compressive Strength at 28 days	41 psi	120 psi
Coefficient of Permeability (cm/sec) @ 13.8 kPa (2.0 psi)	1x10-5	1x10-6

PART 3 - EXECUTION

3.01 GENERAL

A. Site Conditions. Examine the areas for work of this Section. The contractor shall correct conditions detrimental to timely and proper completion of the work.

B. Preparation. The installation of the cellular concrete shall be in accordance with procedures provided by the manufacturer. The area to be filled shall not have any standing water in it prior to cellular concrete placement. Items encased in the cellular concrete shall be set and stable prior to installation.

C. Installation.

1. Use automated job site batching, mixing, and placing equipment approved by the Engineer. Mix the materials and convey promptly to the point of placement. Cast the cellular concrete in lifts to prevent segregation or stratification in which the upper portions of a lift

may be lighter due to rising of the air bubbles toward the top of the lift, and /or the lower portions may be denser due to factors such as compression of the air bubbles under the weight of the overlying material, or settlement of the cement paste toward the bottom of the lift. The final surface finish shall be within ± 0.16 foot of plan elevation.

2. Lift thickness for cellular concrete shall not exceed 2.5 ft. If more than one lift is required, the layer to receive the next lift shall be scarified with a broom or rake to provide surface roughness. After curing for 12 hours, any crumbling area on the surface should be removed and scarified before the next layer is placed. Surface stepping shall be limited to 5 in. Grades of up to 5 percent may be made by adding a thickening agent to the mix, in conformance with the manufacturer's recommendations.

3. A minimum 12-hour waiting time between lifts shall be required. If ambient temperatures are anticipated to be below 40 degrees Fahrenheit within 24 hours after placement, the mixing water should be heated when specifically approved by the manufacturer of the foaming agent, or placement shall be prohibited during such period. Placement shall not be allowed on frozen ground.

4. After placing the final lift of cellular concrete, the exposed surface of shall be covered with a prime coat. The prime coat shall conform to the requirements in Section 02720, "Asphalt Paving," of the Standard Specifications. A coat of SS-1 Asphaltic Emulsion shall be applied uniformly at a rate of between 0.15 and 0.25 gallons per square-yard, with the exact rate determined by the Engineer.

D. Sampling. During placement of the initial batches, check the density and adjust the mix as required to obtain the specified cast density at the point of placement. Take four test specimens for each 300 cubic yards of cellular concrete placed or for each four hours of placing, whichever comes first.

E. Testing. Test in accordance with ASTM C 796 except do not oven dry the load test specimens. The specimens shall be made in special Styrofoam molds that contain four (4) 3" x 6" cylinders covered after casting to prevent damage and loss of moisture. Moisten cure specimens for a period up to 7 days prior to a 28-day compressive strength test. Specimens may be tested at any age to monitor the compressive strength.

If the average compressive strength of any set of three concrete cylinders broken at 28 days, does not achieve the specified amount, the Engineer may require the Contractor to do one or more of the following, at the Contractor's expense:

1. Additional field testing by coring to determine if in-place compressive strength meets specified requirement. The Contractor shall repair all core holes as approved by the Engineer.

2. Removal and replacement of the work.

3. Other procedures determined by the Engineer.

END OF SECTION

SECTION 03400

PRECAST CONCRETE STRUCTURES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for precast concrete items including mini-high platforms. Work in this section includes design to be performed by Contractor.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

2. A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

3. C31 Standard Test Practice for Making and Curing Concrete Test Specimens in the Field

4. C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

5. C260 Standard Specification for Air-Entraining Admixtures for Concrete

6. C494 Standard Specification for Chemical Admixtures for Concrete

7. C618 Standard Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

B. American Welding Society (AWS):

1. D1.1 Structural Welding Code – Steel

2. D1.4 Structural Welding Code – Reinforcing Steel

C. State of California, Department of Transportation (Caltrans), Standard Specifications:

1. Section 51 Concrete Structures

D. Precast/Prestressed Concrete Institute (PCI):

1. MNL-116-21 Manual for Quality Control for Plants and Production of Structural Precast Concrete Products

2. MNL-120-17 Design Handbook – Precast and Prestressed Concrete

1.03 SYSTEM DESCRIPTION

A. Design precast components in accordance with PCI MNL 120.

B. Fabricate and erect precast concrete units in accordance with PCI MNL-116, as indicated on the Contract Drawings and as specified herein.

1.04 SUBMITTALS

A. Shop Drawings: Submit shop drawings and structural calculations prepared by an experienced professional detailer showing complete information for fabrication and installation of precast concrete units. Indicate unit dimensions and cross-section; fabrication tolerances; location, size, and type of reinforcement, including special reinforcement; and lifting devices necessary for handling and erection.

1. Show layout, dimensions, and identification of each precast unit corresponding to sequence and procedure of installation.

2. Indicate welded connections by AWS standard symbols. Detail inserts, connections, and joints, including accessories and construction at openings in precast units.

3. Quantities, dimensions, and locations of sleeves, anchors, brackets, inserts, reglets, accessories, and methods of securing same in forms.

4. Casting, consolidating, and finishing procedures.

5. Include setting diagrams and instructions as required for installation.

B. Submit concrete mix designs as specified under Section 03300, Cast-In-Place Concrete.

C. Comply with the submittal requirements specified in Section 03200, Concrete Reinforcing, and Section 03300, Cast-In-Place Concrete.

D. Product Data: Submit manufacturer's product data of manufactured products and accessories. Include manufacturer's detailed drawings and dimensions when applicable.

E. Quality Assurance Submittals:

1. Submit evidence of current plant certification under the PCI Plant Certification Program.

2. Submit qualifications of fabricator including a list of three successfully completed precast jobs of similar type and size to the project. Include a detailed description of the fabricated structure, project name, location, general contractor, and engineer.

3. For welders, furnish welding certificates or affidavits attesting to the welders' qualifications to perform the indicated and specified welding.

Welders shall be prequalified in accordance with AWS D1.1 or AWS D1.4, as applicable to the work.

1.05 QUALIFICATIONS OF THE FABRICATOR

A. Plant shall be PCI certified under the PCI Plant Certification Program or equivalent and regularly engaged in design and construction of structural precast concrete with a minimum of five (5) years' experience. PCI Certification shall be in a product group and category appropriate to the work.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Transport, handle, and store precast units in a manner that will prevent damage to the units. Units shall be handled such that the points of the support and direction of the reactions with respect to the unit are approximately the same during transportation and storage as when the unit is in the final position.

B. Store units in a manner that will prevent cracking, distortion, staining, or other damage. The finished precast units shall be stored on wood planks, or other supports to keep items free of dirt and other foreign debris, approximately six (6) inches off the ground.

C. Units damaged by improper storage or handling shall be replaced or repaired to the satisfaction of the Engineer.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Precast concrete members shall conform to the provisions in Caltrans Standard Specifications, Section 51, "Concrete Structures", and as specified herein.

B. Reinforcement: Comply with applicable requirements of Section 03200, Concrete Reinforcing.

C. Concrete: Comply with the applicable requirements of Section 03300, Cast-In-Place Concrete, and the following:

1. Flyash meeting the requirements of ASTM C618, Type C, may be used as a cement replacement only with the approval of the Engineer.

    a. Type F may be used to modify potentially reactive aggregates

    b. Flyash may replace up to 15 percent, by weight, of the cement

2. Admixtures

    a. All admixtures must be from the same manufacturer.

    b. Air-entraining admixtures shall conform to ASTM C260 and shall be used to produce 6 to 8 percent entrained air in the concrete after all admixtures have been incorporated.

c. Water reducing admixtures meeting the requirements of ASTM C494, Type A, may be used only with the approval of the Engineer.

d. Admixtures containing chlorides and sulfides are not acceptable.

3. Maximum total chloride ion content contributed from all ingredients of concrete including water, aggregates, cement, and admixtures measured as a weight percent of cement shall not exceed 0.06.

2.02 FABRICATION

A. Field verify dimensions shown on the Contract Drawings prior to fabrication of any precast concrete structure. Notify the Engineer of any differences between field measurements and those shown on the Contract Drawings.

B. The manufacture, quality, dimensional, and erection tolerances of all precast units shall be in accordance with PCI MNL 116.

C. Forms shall be accurately constructed to produce units to dimension, shape, configuration, and profile indicated. When not otherwise indicated, construct forms to produce smooth concrete.

D. Anchors, Lift Devices, and Accessories: Provide concrete inserts, reglets, anchors, brackets, and fasteners as indicated or required for fabrication and installation work. All items shall be zinc-coated or galvanized in accordance with ASTM A153 or ASTM A123, as applicable. Contractor shall select the lift devices, and shall be responsible for their performance and for any damage resulting from the use of faulty or inferior devices. Lift devices shall not be visible on exposed faces of precast members. Provide a minimum four for each unit.

E. Concrete reinforcement, lifting reinforcement, and concrete inserts and anchorage devices shall be placed and secured against movement as required.

F. Concrete shall be placed and consolidated to shape, configuration, and dimensions indicated.

G. Identification:

1. Identify each precast unit, in a semi-permanent manner, at the precasting yard with respect to the final location.

2. Locate such identification and make it of such material as to withstand wear during shipping and damage from the elements for a period of not less than one year.

3. Protect and preserve identification marks and restore any identification which becomes damaged or partially obliterated.

4. The Engineer reserves the right to reject any unit, and require replacement, if the identification becomes obliterated.

H. Repair or replace any unit which does not conform to the dimensions or structural standards shown on the Contract Drawings or specified herein, and which is not suitable for use as determined by the Engineer.

2.03 FABRICATION TOLERANCES

A. Fabricate precast units conforming to the maximum dimensional tolerances listed in the PCI Standards for precast concrete structures. Units shall be stored in such a way as to permit the Inspector access to all sides at all times.

2.04 SOURCE QUALITY CONTROL

A. The Engineer will perform an inspection of precast concrete structures during the fabrication process at the manufacturing plant.

B. The Contractor-employed independent testing laboratory or agency shall perform such inspections and tests as required to verify compliance with these Specifications, including the following testing:

1. Concrete strength shall be measured on test cylinders cast from the same concrete for the precast structures. These cylinders shall be cured under time-temperature relationships and conditions that simulate those of the precast structures. If the forms are heated by steam or hot air, test cylinders will remain in the coolest zone throughout curing. If forms are heated another way, the Contractor shall provide a record of the curing time temperature relationship for the cylinders for each precast structure to the Engineer. When two or more precast concrete units are cast in a continuous line and in a continuous pour, a single set of test cylinders may represent all precast concrete units provided the Contractor demonstrates uniformity of casting and curing to the satisfaction of the Engineer.

2. The Contractor shall mold, cure, and test enough of these cylinders to satisfy specification requirements for measuring concrete strength. The Contractor may use 6- by 12-inch cylinders. If heat is used to shorten curing time, the Contractor shall let cylinders cool for at least ½ hour before testing.

3. Test cylinders may be cured in a moist room or water tank in accordance with California Test 540 after the concrete has obtained the required release strength. If, however, the Contractor intends to ship the precast structures prior to the standard 28-day strength test, the design strength for shipping shall be determined from cylinders placed with the precast structures and cured under the same conditions as the precast structures. These cylinders may be placed in a noninsulated, moisture-proof envelope.

4. To measure concrete strength in the precast structures, the Contractor shall randomly select two test cylinders and average their compressive strengths. The compressive strength in either cylinder shall not fall more than 5 percent below the specified strength. If these two cylinders do not pass the test, two other cylinders shall be selected and tested.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify acceptability and location of supports to receive precast concrete structures. Examine all parts of the supporting structure and the conditions under which the precast units are to be erected and installed. Check bearing surfaces to determine that they are level and uniform.

3.02 INSTALLATION

A. Perform excavation and backfill operations in accordance with Section 02300, Earthwork.

B. Install precast concrete structures, including precast concrete field joints, in conformance with Caltrans Standard Specifications, Section 51-4, Precast Concrete Members, and as specified herein, and to the stages shown on the Contract Drawings.

C. After the precast structures are set, burn off lifting loops, if any, ¾ inch below the surface of the concrete and patch the resulting recesses with epoxy mortar.

END OF SECTION

SECTION 03450

PRECAST ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for precast architectural concrete items. Work in this section includes design to be performed by Contractor.

1.02 REFERENCE STANDARDS

A. American Concrete Institute (ACI):

1. 318 Building Code Requirements for Structural Concrete

B. ASTM International (ASTM):

1. A36 Standard Specification for Carbon Structural Steel
2. A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
3. A283 Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
4. A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
5. A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
6. A706 Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
7. A767 Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
8. A775 Standard Specification for Epoxy-Coated Steel Reinforcing Bars
9. A1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
10. C33 Standard Specification for Concrete Aggregates
11. C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
12. C150 Standard Specification for Portland Cement
13. C260 Standard Specification for Air-Entraining Admixtures for Concrete

14. C494 Standard Specification for Chemical Admixtures for Concrete

15. C642 Standard Test Method for Density, Absorption, and Voids in Hardened Concrete

16. C979 Standard Specification for Pigments for Integrally Colored Concrete

C. American Welding Society (AWS):

1. D1.1 Structural Welding Code - Steel

2. D1.4 Structural Welding Code – Reinforcing Steel

3. D1.6 Structural Welding Code – Stainless Steel

D. Concrete Reinforcing Steel Institute (CRSI):

1. Manual of Standard Practice

E. Precast/Prestressed Concrete Institute (PCI):

1. MNL-117 Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products

2. MNL-120 Design Handbook – Precast and Prestressed Concrete

1.03 DESIGN REQUIREMENTS

A. Precast concrete units shall be reinforced with new billet steel reinforcing bars, as necessary for safe handling, setting and structural loads, and the size of the reinforcing shall be specified with a minimum area of steel equal to one quarter of one percent of the cross section area. If the surfaces are to be exposed to the weather, the reinforcement shall be galvanized or epoxy coated when covered with less than 2 inches of material for bars larger than 5/8 inch, and 1-1/2 inches for bars 5/8 inch or smaller. The material covering in all cases shall be at least twice the diameter of the bars. Very small non-structural pieces with dimension smaller than 8 x 8 x 4 inch may be made without reinforcing if approved by the Engineer.

B. Reinforcing shall comply with CRSI Manual of Standard Practice.

1.04 SUBMITTALS

A. Mix designs: Submit mix designs along with laboratory test reports, less than 6 months old, performed by a qualified testing agency using the same mix design as proposed for the work showing absorption and compressive strengths meeting the requirements of these specifications. Include names and brands of materials, proportions, slump, strength, and gradation of aggregates.

B. Shop Drawings: Submit shop drawings and structural calculations prepared by an experienced professional detailer showing complete information for fabrication and installation of precast concrete units. Indicate unit dimensions and cross-section; fabrication tolerances; location, size, and type of reinforcement, including special reinforcement; and lifting devices necessary for handling and erection.

1. Show layout, dimensions, and identification of each precast unit corresponding to sequence and procedure of installation.

2. Indicate welded connections by AWS standard symbols. Detail inserts, connections, and joints, including accessories and construction at openings in precast units.

3. Show caulked joints, including expansion joints ("soft" type) and grouted joints ("rigid" type).

4. Show location and details of anchorage devices to be embedded in other construction.

5. Indicate the specified protective finishes for metal items including connectors.

6. Include setting diagrams and instructions as required for installation.

C. Samples: Minimum size 6 x 6 x 2 inches to illustrate the quality, color, and specified surface finish texture.

D. Submit samples or catalog cuts of cast-in gaskets, anchors, and other attachments and accessories.

E. Submit qualifications of fabricator including a list of five successfully completed precast jobs at least five years old. Include a detailed description of the fabricated item, project name, location, general contractor, and architect or engineer.

1.05 QUALITY ASSURANCE

A. Qualifications of Fabricator:

1. Fabricator of precast concrete products shall be an active and approved participant in the PCI Plant Certification Program.

2. Precast concrete work shall be produced in a plant or production facility by a fabricator who has been regularly and continuously engaged in the manufacture of architectural precast concrete product for a minimum of five (5) years.

B. Applicable standards for inspection and quality control shall be PCI MNL 117 and PCI MNL 120.

C. Precast units that are suspended from the structure or carry weight over openings shall be detailed under the supervision of a qualified professional

engineer registered in the State of California if the structural design of the piece is not shown on the Contract Drawings.

D. Installer of precast work shall have a minimum of 3 years' successful experience in erection of architectural precast concrete units similar to units required for the Work.

E. Welding shall conform to the requirements in AWS D1.1, AWS D1.4, and AWS D1.6, as applicable to the work.

F. Qualification of Precast Inspectors: QC Inspectors shall either be 1) licensed as Civil Engineers in the State of California, or 2) have a current Plant Quality Personnel Certification, Level II, from the Precast/Prestressed Concrete Institute. A QC Inspector shall witness all precast concrete operations.

1.06 DELIVERY, STORAGE, AND HANDLING.

A. Store units at project site to prevent cracking, distortion, warping, staining, or other physical damage and so that markings are visible. Lift and support units only at designated lifting or supporting points as shown on approved shop drawings.

PART 2 – PRODUCTS

2.01 REINFORCEMENT

A. Reinforcing Bars: ASTM A615, or ASTM A706, Grade 60, deformed. Reinforcing bars conforming to ASTM A706 shall be used when welding bars.

B. Epoxy-Coated Reinforcing Bars: ASTM A775.

C. Galvanized Reinforcing Bars: ASTM A767, Class II (2.0 oz. zinc psf), hot-dip galvanized after fabrication and bending.

D. Steel Wire: ASTM A82, plain, cold-drawn, steel.

E. Welded Wire Fabric: ASTM A185.

F. Welded Deformed Steel Wire Fabric: A STM A497.

G. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing.

1. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are plastic protected (CRSI, Class I) or stainless steel protected (CRSI, Class 2).

2.02 CONCRETE MATERIALS

A. Use only one brand, type, and source of supply for each type of cement, aggregates, pigments, and other materials affecting color throughout the work.

B. Portland Cement: ASTM C150, Type I or Type III. White cement, gray cement, or a blend of white and gray cement may be used as long as the color is achieved as approved by the Engineer.

C. Coarse Aggregate: ASTM C33; hard, durable, selected, and graded; free of material that causes staining or reacting with cement. Color shall be white. Darker aggregates may be used as long as the color is achieved as approved by the Engineer.

D. Fine Aggregate: ASTM C33; hard, durable, selected, and graded; free of material that causes staining or reacting with cement. Color shall be white. Darker aggregates may be used as long as the color is achieved as approved by the Engineer.

E. Pigments: ASTM C979; Inorganic, nonfading, resistant to lime and other alkalis, and containing no carbon black. Provide ready-to-use, pure, and concentrated pigment material specially processed for mixing into concrete. Pigments shall not to exceed 10 percent of the cement weight.

F. Water: Drinkable, clean, and free of injurious amounts of oil, acid, alkali, salts, organic material, and any other substances that may be harmful to concrete or embedded steel.

G. Air-Entraining Admixture: ASTM C260

H. Water-Reducing, Retarding, or Accelerating Admixtures: ASTM C494, type as selected by fabricator. Admixtures containing chlorides and sulfides are not acceptable.

2.03 CONNECTION MATERIALS

A. Steel Plates: Structural quality, hot-rolled carbon steel, ASTM A283, Grade C

B. Steel Shapes: ASTM A36

C. Stainless Steel Shapes: AISI Type 302/304

D. Anchor Bolts: ASTM A307, low-carbon steel bolts, regular hexagon nuts and carbon steel washers

E. Electrodes for Welding:

1. Steel plates and shapes: E70 meeting the requirements of AWS D1.1, and as applicable to plates conforming to ASTM A283

2. Reinforcing bars: E90 meeting the requirements of AWS D1.4

3. Stainless steel: E70 meeting the requirements of AWS D1.6

F. Cast-In Items: Provide reglets, slots, holes, inserts, and other accessories in units to receive dowels, reglets, flashings, anchors and other similar work as indicated.

G. Anchorages: Provide loose steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other miscellaneous loose steel shapes, necessary for securing precast units to supporting and adjacent members.

H Finish of Steel Cast-In Items: Items exposed to weather shall be hot-dip galvanized after fabrication in accordance with ASTM A153. Items not exposed to weather shall be painted with one coat of rust-inhibitive primer. Threaded inserts cast into precast units shall be hot-dip galvanized, electrogalvanized, or cadmium plated.

2.04 MISCELLANEOUS MATERIALS

A. Cast-In Items: Provide waterstops and similar accessories as indicated.

B. Sealer Finish: Exterior, high-build, water based low VOC, non-yellowing, clear polyurethane sealer applied to form a transparent protective film on the precast architectural concrete surfaces to minimize maintenance and applied to after concrete is fully cured per ASTM C309.

1. Rustoleum Concrete Saver 6711 System Clear, Water-Based Polyurethane, clear 1 G or Approved Equal.

2.05 MIX DESIGN

A. Prepare design mix for the type of concrete required. Unless otherwise noted, all architectural precast shall be the same color and of the same mix design.

B. Obtain design mixes from an independent testing facility or qualified precast manufacturing plant personnel, at precast fabricator's option.

C. Proportion mixes by either laboratory trial batch or field experience methods, using materials to be employed on the project for each type of concrete required, complying with ACI 318.

D. Mix Properties: Standard-weight concrete consisting of specified Portland cement, aggregates, pigments, admixtures, and water to produce the following properties.

1. Compressive Strength: 5,000 psi minimum at 28 days. Tests shall be performed by a professional testing laboratory using 6" x 12" cylinders per ASTM C39.

2. Total Air Content: Minimum 4 percent, maximum 7 percent

3. Water Absorption: Not to exceed 5 percent by weight when tested per ASTM C642.

4. Color: Except as otherwise indicated, integral custom colored mix to match a colored sample provided by the Engineer.

E. Adjustment to Concrete Mixes: Mix design adjustments may be requested when characteristics of materials, job conditions, weather, test results, or other circumstances warrant. Submit laboratory test data for revised mix designs and

strength results to the Engineer and obtain Engineer's acceptance before using in the work.

F. Admixtures: Use air-entraining admixture in strict compliance with admixture manufacturer's directions. Other admixtures to increase cement dispersion or provide increased workability for low-slump concrete may be used subject to Engineer's acceptance. Use amounts as recommended by admixture manufacturer for climatic conditions prevailing at time of casting. Adjust quantities of admixtures as required to maintain quality control.

2.06 FABRICATION

A. General: Fabricate precast concrete units complying with manufacturing and testing procedures, quality control recommendations, and dimensional tolerances as described herein, unless otherwise indicated.

B. Provide forms and, where required, form-facing materials of metal, plastic, wood, or other acceptable material that is nonreactive with concrete and will produce required finish surfaces per the approved sample. Accurately construct forms mortar-tight and of sufficient strength to withstand pressures due to concrete placing operations, and temperature changes. Maintain form work to provide completed precast concrete trim units of shapes, lines, and dimensions indicated, within specified fabrication tolerances.

C. Dimensional Tolerances of Finished Units:

1. Overall height and width measured at face adjacent to mold at time of casting: Plus or minus 1/8 inch.

2. Angular deviation of plane of side mold: 1/32 inch per 3 inches depth or 1/16 inch total, whichever is greater.

3. Out of square (difference in length of two diagonal measurements): 1/8 inch per 6 feet or 1/4 inch total, whichever is greater.

4. Thickness: Minus 1/8 inch, plus 1/4 inch

5. Tolerances of other dimensions not otherwise indicated: Numerically greater of plus or minus 1/16 inch per 10 feet, or plus or minus 1/8 inch.

6. Other tolerances per PCI MNL-117

D. Position Tolerance: For cast-in items measured from datum line locations as shown on approved shop drawings:

1. Anchors and inserts: Within 3/8 inch of centerline location shown on shop drawings.

2. Blockouts and reinforcements: Within 1/4 inch of position shown on shop drawings, where such positions have structural implications or affect concrete cover; otherwise within plus or minus 1/2 inch.

E. Fabricate units straight, smooth, and true to size and shape, with exposed edges and corners formed or stoned to a minimum radius unless otherwise indicated.

1. Precast trim units that are cracked, broken, spalled, stained, or exceeding the specified manufacturing tolerances will not be acceptable.

F. Curing: Cure units in a warm, moist, totally enclosed curing room for a minimum of 20 hours.

G. Surface Finish: Remove all surface cement paste by means of acid etching or lightly sandblasting to provide a smooth, dense, fine-grained texture with no streaks or blotches. Texture and quality of finish shall match approved sample when viewed in direct daylight at a 10 foot distance.

H. Color: The color shall be match approved sample when viewed in direct daylight at a 10 foot distance. Color variation between pieces shall be minimal as determined by the Engineer.

2.07 SOURCE QUALITY CONTROL

A. Testing: Test specimens shall be prepared by an ACI certified Grade 1 Field Testing Technician. Tests shall be performed by a certified testing laboratory hired by the Contractor. Keep test results on file for at least two years and submit to the Engineer upon request.

1. Perform one set of 6 inches x 12 inches cylinder tests for every 500 cubic feet of concrete placed. Perform at least one set of cylinder tests for work that requires more than 25 cubic feet of concrete but less than 500 cubic feet.

2. Perform one absorption test for every 500 cubic feet of concrete placed. Perform at least one absorption test for work that requires more than 25 cubic feet of concrete but less than 500 cubic feet.

PART 3 – EXECUTION

3.01 INSTALLATION

A. General: Deliver anchorage items to be embedded in other construction before start of such work.

B. Do not install precast units until supporting concrete has attained minimum allowable design compressive strength.

C. Do not install any precast units that have any defects that exceed the acceptable PCI MNL-117 tolerances for dimensions and color if installation would result in unsatisfactory performance or appearance as determined by the Engineer.

D. Install precast concrete members plumb, level, and in alignment in accordance with PCI MNL-117 erection tolerances. Utilize fabricator provided templates. Provide temporary supports and bracing as required to maintain position, stability, and alignment as members are being permanently connected.

1. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.

E. Accessories: Install clips, hangers, and other accessories required for erection of precast units to supporting members and backup materials.

F. Anchor units in final position by bolting, welding, grouting, or as otherwise indicated on the Contract Documents. Remove temporary shims, wedges, and spacers as soon as possible after anchoring and grouting are completed.

1. At bolted connections use lock washers or other acceptable means to prevent loosening of nuts.

2. At welded connections apply rust-inhibitive coating on damaged areas, same as shop-applied material. Use galvanizing repair coating on galvanized surfaces.

G. Before pointing and caulking, scrub face of precast with a fiber brush, using mild detergent and water and then thoroughly rinse with clean running water. Remove any mortar on the face of the precast. Do not use acids or prepared cleaners without the approval of the precast fabricator.

3.02 PROTECTION AND REPAIR

A. Protect the precast units from discoloration and staining when washing down the surrounding masonry by covering the precast units with plastic sheeting and/or by thoroughly soaking them with clear water so they will not absorb any of the dirty washdown water that may run onto them. If dirty washdown water gets on the precast, hose it off immediately with clear water.

B. Repair or replace chipped or damaged precast items to the satisfaction of the Engineer. Repair of chipped or damaged precast shall be done only by mechanics skilled in this class of work, with materials and instructions furnished by the fabricator.

C. Replace chipped or damaged precast units that cannot be repaired.

D. After concrete has fully cured to meet sealer manufacturer's application instructions apply two coats of exterior, clear, water based sealer described in Article 2.04 Miscellaneous Materials, paragraph B, Sealer Finish.

END OF SECTION

SECTION 03500

CAST-IN-DRILLED-HOLE CONCRETE PILING

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes specifications for constructing Cast-In-Drilled-Hole (CIDH) concrete piles and CIDH concrete pile rock sockets.

1.02 DEFINITIONS

A. Dry Hole: Except for CIDH concrete piles specified as end bearing, a drilled hole that:

1. Accumulates no more than 12 inches of water in the bottom of the drilled hole during a period of 1 hour without any pumping from the hole during the hour.

2. Has no more than 3 inches of water in the bottom of the drilled hole immediately before placing concrete.

3. For CIDH concrete piles specified as end bearing, a drilled hole free of water without the use of pumps.

1.03 REFERENCE STANDARDS

A. State of California Department of Transportation (Caltrans) Standard Specifications:

1. Section 49-3.02 Cast-In-Drilled-Hole Concrete Piling

B. California Test Methods

1. Test 233 Method of Ascertaining the Homogeneity of Concrete in Cast-In-Drilled-Hole (CIDH) Piles Using the Gamma-Gamma Test Method.

2. Test 556 Method of Test for Slump of Fresh Portland Cement Concrete

C. International Association of Foundation Drilling (ADSC)

1. Standard Mitigation Plan

D. Concrete Reinforcing Steel Institute (CRSI) Manual of Standard Practice

1. Section 3.4 All-Plastic Bar Supports

2. Section 3.5 Side-Form Spacers

1.04 SUBMITTALS

A. Pile Installation Plan: Submit a pile installation plan. Include complete descriptions, details, and supporting calculations for the following:

1. Concrete mix design, certified test data, and trial batch reports.

2. Drilling or coring methods and equipment.

3. Proposed method for casing installation and removal, if necessary.

4. Methods for placing, positioning, and supporting bar reinforcement.

5. Methods and equipment for determining:

   a. Depth of concrete.

   b. Theoretical volume of concrete to be placed, including the effects on volume if casings are withdrawn.

   c. Actual volume of concrete placed.

6. Methods and equipment for verifying the bottom of the drilled hole is clean before placing concrete.

7. Methods and equipment for preventing upward movement of reinforcement, including the means of detecting and measuring upward movement during concrete placement activities.

8. Drilling sequence and concrete placement plan.

9. For concrete placed under slurry, include complete descriptions, details, and supporting calculations in the pile installation plan for:

   a. Concrete batching, delivery, and placing systems, including time schedules and capacities. Time schedules must include the time required for each concrete placing activity at each pile.

   b. Concrete placing rate calculations. If requested, base calculations on the initial pump pressures or static head on the concrete and losses throughout the placing system, including anticipated head of slurry and concrete to be displaced.

   c. Suppliers' test reports on the physical and chemical properties of the slurry and any proposed slurry chemical additives, including MSDSs.

   d. Slurry testing equipment and procedures.

   e. Methods of removal and disposal of slurry and contaminated concrete, including removal rates.

f. Methods and equipment for slurry agitating, recirculating, and cleaning.

10. Include a mitigation plan for equipment failure under track shutdowns. Address alternative methods for CIDH casing installation and placement.

B. Mitigation Plans: For each rejected pile, submit a mitigation plan for repair, supplementation, or replacement. The mitigation plan must:

1. Comply with Section 1300 Submittals and Deliverables for shop drawings.

2. Be sealed and signed by an engineer who is registered as a civil engineer in the State of California. This requirement is waived for either of the following conditions:

a. The proposed mitigation will be performed under the current Caltrans version of ADSC Standard Mitigation Plan 'A' – Basic Repair without exception or modification.

b. The Engineer determines that the rejected pile does not require mitigation due to structural, geotechnical, or corrosion concerns, and you elect to repair the pile using the current Caltrans version of ADSC Standard Mitigation Plan 'B' - Grouting Repair without exception or modification.

3. Pile mitigation plans must include:

a. Designation and location of the rejected pile.

b. Review of the structural, geotechnical, and corrosion design requirements of the rejected pile.

c. Step by step description of the mitigation work to be performed, including drawings if necessary.

d. Assessment of how the proposed mitigation work addresses the structural, geotechnical, and corrosion design requirements of the rejected pile.

e. Methods for preservation or restoration of existing earthen materials.

f. List of any affected existing facilities. Include methods and equipment to be used for the protection of existing facilities during mitigation.

g. Your name and the names of any subcontractors on each sheet.

h. List of materials with quantity estimates for the mitigation work and a list of personnel with their qualifications who will be performing the mitigation work.

4. For rejected piles to be repaired, include the following in the pile mitigation plan:

    a. Assessment of the nature, depth and size of the anomalies in the rejected pile.

    b. Provisions for access for additional pile testing, if requested.

5. For rejected piles to be replaced or supplemented, include the following in the pile mitigation plan:

    a. Proposed location and size of additional piles.

    b. Structural details and calculations for any modification to the structure to accommodate the replacement or supplemental piles.

6. Replacement piles must comply with the Contract for CIDH concrete piles.

1.05 DELIVERABLES

A. If plastic spacers are proposed for use, submit the manufacturer's data and a sample of the plastic spacer.

B. Inspection Pipe Coupler Log: Where inspection pipes are required, submit a log of the locations of inspection pipe couplers upon completion of concrete placement in the hole.

C. Concrete Placement Log: Submit the concrete placement log within 1 business day of completion of concrete placement in the hole.

D. Coring Logs and Concrete Cores: If coring is performed, submit coring logs and concrete cores.

E. Testing Report: Submit a testing report for each pile tested. The report must be sealed and signed by an engineer who is registered as a civil engineer in the State of California. The testing report shall comply with the requirements of California Test 233.

F. Mitigation Report: If repairs are performed, submit a mitigation report within 10 days of completion of the repair. The report must state exactly what repair work was performed and quantify the success of the repairs relative to the submitted mitigation plan. The mitigation report must be sealed and signed by an engineer who is registered as a civil engineer in the State of California. The mitigation report must include your name and the names of any subcontractors on each sheet.

1.06 QUALITY ASSURANCE

A. Preconstruction Meeting: Schedule and hold a preconstruction meeting for CIDH concrete pile construction (1) at least 5 business days after submitting the pile

installation plan and (2) at least 10 days before the start of CIDH concrete pile construction.

1. The meeting must include the Engineer, Contractor representatives, and any subcontractors involved in CIDH concrete pile construction.

2. The purpose of this meeting is to:

    a. Establish contacts and communication protocol between Contractor representatives, any subcontractors, and the Engineer.

    b. Review the construction process, acceptance testing, and anomaly mitigation of CIDH concrete piles.

3. The Engineer will conduct the meeting. Be prepared to discuss the following:

    a. Safety requirements, including Cal/OSHA and Tunnel Safety Orders. Address training of workers and worker safety prior to, during and after construction.

    b. Pile placement plan, dry and wet.

    c. Acceptance testing, including gamma-gamma logging, cross-hole sonic logging, and coring.

    d. Pile Design Data Form.

    e. Mitigation process.

    f. Timeline and critical path activities.

    g. Structural, geotechnical, and corrosion design requirements.

    h. Future meetings, if necessary, for pile mitigation and pile mitigation plan review.

B. Concrete Test Batch: This section applies at locations where concrete is placed under slurry.

1. Before placing concrete under slurry, produce a concrete test batch and transport it to the job site under the same conditions and in the same time frame that is anticipated during the placement of concrete in the piles.

2. At the job site, place the test batch concrete in an excavated hole or suitable container to allow for testing. Placing concrete under slurry is not required. The test batch must demonstrate that the proposed mix design will achieve the minimum required slump after the specified set period.

3. Do not vibrate or agitate the concrete during the set period.

4. Test the concrete for slump under California Test 556. In addition to meeting the specified nominal slump, the slump of the concrete must comply with the requirements shown in the following table:

Slump Requirements

Time required to place concrete[a], T	Minimum set period before testing[b]	Slump, after set period
T ≤ 2 hours	2T	≥ 7 inches
T > 2 hours	T + 2 hours	≥ 7 inches

[a]As described in the pile installation plan.
[b]The set period starts at the start of concrete placement.

5. After testing, dispose of the concrete test batch.

C. Acceptance Testing: This Section applies to CIDH concrete piles except for piles (1) less than 24 inches in diameter or (2) constructed in dry holes without the use of a temporary casing to control ground water or to prevent quick soil conditions or caving of the drilled hole.

1. Perform acceptance testing using gamma-gamma logging to test the concrete density of the pile for homogeneity.

2. After notification by the Engineer of pile acceptance, dewater the inspection pipes and cored holes and fill them with grout. Grout must comply with section 50-1.02C Grout of the Caltrans Standard Specifications. Fill inspection pipes and holes using grout tubes that extend to the bottom of the pipe or hole or into the grout already placed.

3. Vertical Inspection Pipes: If the drilled hole is dry or dewatered without the use of temporary casing to control ground water, installation of inspection pipes is not required. Install vertical inspection pipes for acceptance testing as follows:

a. Inspection pipes must be schedule 40 PVC pipe complying with ASTM D 1785 with a nominal pipe size of 2 inches. Watertight PVC couplers complying with ASTM D 2466 are allowed to facilitate pipe lengths in excess of those commercially available. Log the location of the inspection pipe couplers with respect to the plane of pile cutoff. These logs shall be delivered to the Engineer upon completion of the placement of concrete in the drilled hole.

b. Cap each inspection pipe at the bottom. Extend the pipe from 3 feet above the pile cutoff to the bottom of the reinforcing cage. Provide a temporary top cap or similar means to keep the pipes clean before testing. If pile cutoff is below the ground surface or working platform, extend inspection pipes to 3 feet above the ground surface or working platform.

c. If any changes are made to the pile tip, extend the inspection pipes to the bottom of the reinforcing cage.

d. Install inspection pipes in a straight alignment, parallel to the main reinforcement, and securely fastened in place to prevent misalignment during installation of the reinforcement and placing of concrete in the hole. Construct CIDH concrete piles such that the relative distance of inspection pipes to vertical steel reinforcement remains constant.

e. Fill inspection pipes with water upon completion of the concrete placement to prevent debonding of the pipe.

f. Inspection pipes must be completely clean, dry, and unobstructed at the time of testing providing a 2-inch diameter clear opening.

g. Provide safe access to the tops of the tubes.

4. After placing concrete and before requesting acceptance testing, test each inspection pipe in the presence of the Engineer by passing a 1-1/4-inch-diameter by 4.5-foot-long rigid cylinder through the length of pipe.

5. If an inspection pipe fails to pass the rigid cylinder:

   a. Immediately fill all inspection pipes in the pile with water

   b. Core a nominal 2-inch diameter hole through the concrete for the entire length of the pile for each inspection pipe that does not pass the rigid cylinder

   c. Locate cored holes as close as possible to the inspection pipes they are replacing and no more than 5 inches clear from the reinforcement

6. Coring must not damage the pile reinforcement. Core holes using a double wall core barrel system with a split tube type inner barrel. Coring with a solid type inner barrel is not allowed. Coring methods and equipment must provide intact cores for the entire length of the pile. Preserve cores and identify them with the exact location the core was recovered from the pile.

7. The coring activity must be logged by an engineering geologist or civil engineer licensed in the State of California and experienced in core logging. Coring logs must comply with the Caltrain Soil and Rock Logging, Classification, and Presentation Manual. Coring logs must include core recovery, rock quality designation, locations of breaks, and complete descriptions of inclusions and voids encountered during coring.

8. The Engineer evaluates the portion of the pile represented by the cored hole based on the submitted core logs. If the Engineer determines that a pile is anomalous based on the coring logs, the pile is rejected.

9. Gamma-Gamma Logging: Perform gamma-gamma logging under California Test 233.

    a. Separate reinforcing steel as necessary to allow the Engineer access to the inspection pipes.

    b. After requesting testing perform the testing and provide the pile acceptance Test Report within 15 days.

    c. During testing, do not perform construction activities within 25 feet of any gamma-gamma logging activity.

    d. If the Engineer determines that a pile is anomalous under California Test 233, part 5C, the pile is rejected.

D. Rejected Piles: If a pile is rejected:

1. Suspend concrete placement in the remaining piles.

2. Revise the pile installation plan and submit it to the Engineer.

3. Do not resume concrete placement until the revised pile installation plan is authorized by the Engineer.

4. Allow 15 days for the Engineer to determine whether the rejected pile requires mitigation and to provide this information to you. Day 1 of the 15 days is the 1st day after the Engineer has been provided the acceptance Testing Report.

5. The Engineer may require additional tests to further evaluate a rejected pile. These tests may include crosshole sonic logging and other means of inspection selected by the Engineer. The pile acceptance test report will indicate if the Engineer intends to perform any additional testing and when the testing will be performed. Allow the Engineer 20 additional days for a total of 50 days to perform these tests and to provide supplemental results.

6. You may perform testing on the rejected pile.

7. The Engineer determines whether the rejected pile requires mitigation due to structural, geotechnical, or corrosion concerns. The Engineer considers the estimated size and location of the anomaly and potential effects on the design. The Engineer provides you with the conclusions of this analysis for developing the mitigation plan.

8. If a rejected pile requires mitigation or you elect to repair a rejected pile that does not require mitigation, submit a mitigation plan for the repair, supplementation, or replacement of the rejected pile.

9. If the Engineer determines that it is not feasible to repair the rejected pile, submit a mitigation plan for replacement or supplementation of the rejected pile.

10. If the Engineer determines it is not feasible to use one of ADSC's standard mitigation plans to mitigate the pile, schedule a meeting and meet with the Engineer before submitting a nonstandard mitigation plan. The meeting attendees must include your representatives and the Engineer's representatives involved in the pile mitigation. The purpose of the meeting is to discuss the type of pile mitigation acceptable to the Owner. The Engineer conducts the meeting.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Concrete: Concrete placed under slurry must:

1. Contain not less than 675 pounds of cementitious material per cubic yard and be proportioned to prevent excessive bleed water and segregation. The nominal slump shall be equal to or greater than 7 inches.

B. Aggregate Gradings: For concrete placed under slurry, the combined aggregate grading must comply with the 1/2-inch maximum grading or the 3/8-inch maximum grading specified in section 90-1.02C(4) Aggregate Gradation of the Caltrans Standard Specifications.

C. Permanent Steel Casings: Permanent steel casings must comply with section 49-3.02C(6) Permanent Steel Pipe Piling of the Caltrans Standard Specifications.

D. Grout: Grout must consist of cementitious material and water, and may contain an admixture if authorized. Do not exceed 5 gallons of water per 94 lb of cement.

1. Cementitious material must comply with section 90-1.02B Cementitious Materials of the Caltrans Standard Specifications, except SCMs are not required.

2. Water must comply with section 90-1.02D Water of the Caltrans Standard Specifications. If municipally supplied potable water is used, the testing specified in section 90-1.02D is waived.

3. Admixtures must comply with section 90 Concrete of the Caltrans Standard Specifications, except admixtures must not contain chloride ions in excess of 0.25 percent by weight.

4. Use aggregate to extend the grout as follows:

a. Aggregate must consist of at least 70 percent fine aggregate and approximately 30 percent pea gravel, by weight.

b. Fine aggregate must comply with section 90-1.02C(3) Fine Aggregate of the Caltrans Standard Specifications.

c. Size of pea gravel must be such that 100 percent passes the 1/2-inch sieve, at least 85 percent passes the 3/8-inch sieve, and not more than 5 percent passes the no. 8 sieve.

d. Minimum cementitious material content of the grout must not be less than 845 lb/cu yd of grout.

5. Mix the grout as follows:

a. Add water to the mixer followed by cementitious material, aggregates, and any admixtures.

b. Mix the grout with mechanical mixing equipment that produces a uniform and thoroughly mixed grout.

c. Agitate the grout continuously until the grout is pumped.

d. Do not add water after initial mixing.

E. Slurry

1. Mineral Slurry: Mineral slurry must be mixed and thoroughly hydrated in slurry tanks. Sample and test slurry from the slurry tanks before placement in the drilled hole.

2. Recirculate or continuously agitate slurry in the drilled hole.

3. For recirculated slurry:

a. Remove drill cuttings from the slurry before discharging the slurry back into the drilled hole.

b. Sample and test slurry at least every 2 hours after starting its use until tests show that the samples taken from the slurry tank and from near the bottom of the hole have consistent specified properties. Once consistent properties have been achieved, sample slurry at least twice per shift as long as the specified properties remain consistent.

4. For nonrecirculated slurry:

a. Sample and test slurry from the drilled hole at least every 2 hours after starting its use. Sample the slurry at mid-height and near the bottom of the hole.

b. Recirculate slurry if tests show samples taken from mid-height and near the bottom of the hole do not have consistent specified properties.

5. Sample and test slurry before final cleaning of the bottom of the hole and again just before placing concrete. Sample the slurry at mid-height and near the bottom of the hole. Cleaning of the bottom of the hole and placement of the concrete must not start until tests show that the samples have consistent specified properties.

6. Mineral slurry must comply with the requirements shown in the following table:

Mineral Slurry Requirements[a]

Property	Test method	Value
Density Before placement in the drilled hole and during drilling Before final cleaning and immediately before placing concrete	Mud Weight (Density), API 13B-1 section 1	64.3–69.1 pcf[b] 64.3–75.0 pcf[b]
Viscosity Bentonite Attapulgite	Marsh Funnel and Cup. API 13B-1, section 2.2	28–50 sec/qt 28–40 sec/qt
Ph	Glass electrode pH meter or pH paper	8–10.5
Sand content Before final cleaning and immediately before placing concrete	Sand, API 13B-1, section 5	≤ 4.0 percent

[a]Slurry temperature must be at least 40 degrees F when tested.
[b]If authorized, you may use slurry in salt water. The allowable density of slurry in salt water may be increased up to 2 pcf.

7. Remove any caked slurry on the sides or bottom of hole before placing reinforcement.

8. When concrete is not placed immediately after placing reinforcement, the reinforcement must be removed and cleaned of slurry, the sides of the drilled hole must be cleaned of caked slurry, and the reinforcement again placed in the hole for concrete placement.

9. Synthetic Slurry: Synthetic slurry material and property requirements are specified in paragraph d below.

    a. Do not use synthetic slurries in holes drilled in primarily soft or very soft cohesive soils as determined by the Engineer.

    b. A manufacturer's representative must:

        1. Provide technical assistance for the use of their material.

        2. Be at the job site before introduction of the synthetic slurry into the drilled hole.

        3. Remain at the job site until released by the Engineer.

    c. Sample and test synthetic slurries:

        1. When the slurry temperature is at least 40 degrees F.

        2. At mid-height and near the bottom of the hole.

3. During drilling to verify the slurry properties.

4. When drilling is complete but before final cleaning of the bottom of the hole. When samples comply with the requirements shown in the tables for the slurry material selected, clean the bottom of the hole of any loose or settled material.

5. After final cleaning and before placing concrete.

d. The synthetic slurry must be one of the materials shown in the following table:

Material	Manufacturer
SlurryPro CDP	KB INTERNATIONAL LLC 735 BOARD ST STE 209 CHATTANOOGA TN 37402 (423) 266-6964
Super Mud	PDS CO INC 105 W SHARP ST EL DORADO AR 71731 (870) 863-5707
Shore Pac GCV	CETCO CONSTRUCTION DRILLING PRODUCTS 2870 FORBS AVE HOFFMAN ESTATES IL 60192 (800) 527-9948
Terragel or Novagel Polymer	GEO-TECH SERVICES LLC 220 N. ZAPATA HWY STE 11A-449A LAREDO TX 78043 (210) 259-6386

1. Use synthetic slurries in compliance with the manufacturer's instructions. Synthetic slurries shown in the above table may not be appropriate for a given job site.

2. SlurryPro CDP synthetic slurry must comply with the requirements shown in the following table:

SLURRYPRO CDP

Property	Test	Value
Density During drilling Before final cleaning and immediately before placing concrete	Mud Weight (density), API 13B-1, section 1	 ≤ 67.0 pcf[a] ≤ 64.0 pcf[a]
Viscosity During drilling Before final cleaning and immediately before placing concrete	Marsh Funnel and Cup. API 13B-1, section 2.2	 50–120 sec/qt ≤ 70 sec/qt
pH	Glass electrode pH meter or pH paper	6.0–11.5
Sand content, percent by volume Before final cleaning and immediately before placing concrete	Sand, API 13B-1, section 5	≤ 0.5 percent

[a]If authorized, you may use slurry in salt water. The allowable density of slurry in salt water may be increased by 2 pcf. Slurry temperature must be at least 40 degrees F when tested.

3. Super Mud synthetic slurry must comply with the requirements shown in the following table:

SUPER MUD

Property	Test	Value
Density During drilling Before final cleaning and immediately before placing concrete	Mud Weight (density), API 13B-1, section 1	 ≤ 64.0 pcf[a] ≤ 64.0 pcf[a]
Viscosity During drilling Before final cleaning and immediately before placing concrete	Marsh Funnel and Cup. API 13B-1, section 2.2	 32–60 sec/qt ≤ 60 sec/qt
pH	Glass electrode pH meter or pH paper	8.0–10.0
Sand content, percent by volume Before final cleaning and immediately before placing concrete	Sand, API 13B-1, section 5	≤ 0.5 percent

[a]If authorized, you may use slurry in salt water. The allowable density of slurry in salt water may be increased by 2 pcf. Slurry temperature must be at least 40 degrees F when tested.

4. Shore Pac GCV synthetic slurry must comply with the requirements shown in the following table:

SHORE PAC GCV

Property	Test	Value
Density During drilling Before final cleaning and immediately before placing concrete	Mud Weight (density), API 13B-1, section 1	 ≤ 64.0 pcf[a] ≤ 64.0 pcf[a]
Viscosity During drilling Before final cleaning and immediately before placing concrete	Marsh Funnel and Cup. API 13B-1, section 2.2	 33–74 sec/qt ≤ 57 sec/qt
pH	Glass electrode pH meter or pH paper	8.0–11.0
Sand content, percent by volume Before final cleaning and immediately before placing concrete	Sand, API 13B-1, section 5	≤ 0.5 percent

[a]If authorized, you may use slurry in salt water. The allowable density of slurry in salt water may be increased by 2 pcf. Slurry temperature must be at least 40 degrees F when tested.

5. Terragel or Novagel Polymer synthetic slurry must comply with the requirements shown in the following table:

TERRAGEL OR NOVAGEL POLYMER

Property	Test	Value
Density During drilling Before final cleaning and immediately before placing concrete	Mud Weight (density), API 13B-1, section 1	 ≤ 67.0 pcf[a] ≤ 64.0 pcf[a]
Viscosity During drilling Before final cleaning and immediately before placing concrete	Marsh Funnel and Cup. API 13B-1, section 2.2	 45–104 sec/qt ≤ 104 sec/qt
pH	Glass electrode pH meter or pH paper	6.0–11.5
Sand content, percent by volume Before final cleaning and immediately before placing concrete	Sand, API 13B-1, section 5	≤ 0.5 percent

[a]If authorized, you may use slurry in salt water. The allowable density of slurry in salt water may be increased by 2 pcf. Slurry temperature must be at least 40 degrees F when tested.

10. Water Slurry: You may use water as slurry if a casing is used for the entire length of the drilled hole.

    a. Water slurry properties must comply with the requirements shown in the following table:

Water Slurry Requirements

Property	Test	Value
Density Before final cleaning and immediately before placing concrete	Mud Weight (Density), API 13B-1 section 1	63.5 pcf[a]
Sand content Before final cleaning and immediately before placing concrete	Sand, API 13B-1, section 5	≤ 0.5 percent

[a]If authorized, you may use slurry in salt water. The allowable density of slurry in salt water may be increased by 2 pcf.

F. Spacers: Spacers must comply with section 52-1.03D Caltrans Standard Specifications, except you may use plastic spacers. Plastic spacers must:

1. Comply with sections 3.4 and 3.5 of the Concrete Reinforcing Steel Institute's *Manual of Standard Practice*

2. Have at least 25 percent of their gross plane area perforated to compensate for the difference in the coefficient of thermal expansion between the plastic and concrete

3. Be of commercial quality

PART 3 - EXECUTION

3.01 DRILLED HOLES

A. If the piling center-to-center spacing is less than 3 pile diameters, do not drill holes or vibrate casing for an adjacent pile until 24 hours have elapsed after concrete placement in the preceding pile and your prequalification test results for the concrete mix design show that the concrete will attain at least 1800 psi compressive strength at the time of drilling or vibrating.

B. The axis of the drilled hole must not deviate from plumb more than 1-1/2 inches per 10 feet of length.

C. For CIDH concrete piles with a pile cap, the horizontal tolerance at the center of each pile at pile cut-off is the larger of 1/24 of the pile diameter or 3 inches. The horizontal tolerance for the center-to-center spacing of 2 adjacent piles is the larger of 1/24 of the pile diameter or 3 inches.

D. During excavation, do not disturb the foundation material surrounding the pile. Equipment or methods used for excavating holes must not cause quick soil conditions or cause scouring or caving of the hole.

E. For rock sockets, equipment and drill methods must not result in soften materials on the borehole walls.

F. If drilling slurry is used during excavation, maintain the slurry level at least 10 feet above the piezometric head.

G After excavation has started, construct the pile expeditiously to prevent deterioration of the surrounding foundation material from air slaking or from the presence of water. Remove and dispose of deteriorated foundation material, including material that has softened, swollen, or degraded, from the sides and the bottom of the hole.

H. Just before placing reinforcement or concrete, clean the bottom of the hole to remove any loose sand, gravel, dirt, and drill cuttings.

I. After placing reinforcement and before placing concrete in the hole, if caving occurs or deteriorated foundation material accumulates on the bottom of the hole, clean the bottom of the hole. You must verify that the bottom of the hole is clean.

J. Remove water that has infiltrated the hole before placing concrete. Do not allow fluvial or drainage water to enter the hole.

K. Portions of the hole may be enlarged, backfilled with slurry cement backfill, concrete, or other material, and redrilled to the diameter shown to control caving. Backfill material at enlarged piles must be chemically compatible with concrete and steel, be drillable, and have the necessary strength required for the conditions.

L. Dispose of material resulting from placing concrete, in accordance with the requirements of applicable regulatory agencies and project specifications.

M. Notify the Engineer at least 24 hours prior to drilling.

3.02 TEMPORARY STEEL CASINGS

A. Furnish temporary steel casings where necessary to control water or to prevent quick soil conditions or caving of the hole. Place temporary casings tight in the hole.

B. Temporary casings must be:

1. Watertight and of sufficient strength to withstand the loads from installation, removal, lateral concrete pressures, and earth pressures.

2. Noncorrugated with smooth surfaces, clean and free of hardened concrete.

C. Remove the temporary casing during concrete placement. In a dewatered hole, maintain the concrete in the casing at a level of at least 5 feet above the bottom of the casing or at a level above the bottom of the casing adequate to prevent displacement of the concrete by material from outside the casing, whichever is greater.

D. If slurry is not used, do not withdraw the temporary casing until the concrete head in the casing is greater than the groundwater head outside of the casing. Maintain this positive concrete head during withdrawal of the casing.

E. You may vibrate the temporary casing to (1) assist in removal of the casing from the hole, (2) prevent lifting of the reinforcement, and (3) prevent concrete contamination.

F. The withdrawal of casings must not leave voids or cause contamination of the concrete with soil or other materials.

G. The temporary casing may remain in place and replace the permanent steel casing if the placement is as shown and it complies with the specifications for Permanent Steel Casing.

3.03 OBSTRUCTIONS

A. Obstructions shall be defined as any object (such as but not limited to, boulders, logs, old foundations, etc.) that cannot be removed with normal earth drilling procedures, but requires special augers, tooling, core barrels or rock augers to remove the obstruction. When obstructions are encountered, the Contractor shall notify the Engineer and upon concurrence of the Engineer, the Contractor shall begin working to core, break up, push aside, or remove the obstruction. Lost tools or equipment in the excavation as a result of the Contractor's operation shall not be defined as obstructions and shall be removed at the Contractor's expense.

3.04 REINFORCEMENT

A. Reinforcement for CIDH concrete piles with increased diameters and revised tip elevations must comply with the following:

1. Size and number of the reinforcing bars and hoops, the percentage of bars required to extend to the pile tip, and the size and pitch of spiral reinforcement must be the same as shown for the original piles.

2. Required length of any reinforcing bars that do not extend to the pile tip must be at least the length that would have been required for the original specified or ordered tip elevation.

3. Diameter of the spiral or hoop reinforcement must remain the same as required for the original pile or may be increased to provide not less than the concrete cover required for the original pile. Provide positive means to ensure that the reinforcement is centered in the pile.

B. Unless otherwise shown, the bar reinforcing steel cage must have at least 3 inches of clear cover measured from the outside of the cage to the sides of the hole or casing.

C. Place spacers at least 5 inches clear from any inspection tubes.

D. Place plastic spacers around the circumference of the cage and at intervals along the length of the cage, as recommended by the manufacturer.

E. For a single CIDH concrete pile supporting a column, if the pile and the column share the same reinforcing cage diameter, this cage must be accurately placed as shown.

F. If the hole is drilled below the specified tip elevation shown, the reinforcement must extend to within 3 inches of the bottom of the drilled hole.

3.05 PERMANENT STEEL CASING INSTALLATION

A. For permanent steel casings placed in a drilled hole:

1. The casings must be watertight and of sufficient strength to prevent damage and to withstand the loads from installation activities, drilling and tooling equipment, lateral concrete pressures, and earth pressures.

2. Use spacers to center the casing inside the drilled hole. You may weld spacers to the outside of the casing.

3. Fill voids in the annular space between the casing and the soil with grout.

4. Place grout from the bottom of the casing using grout tubes. Place grout continuously until all voids have been filled and the grout reaches the top of the casing. Free fall of the grout from the top to the bottom of the casing is not allowed.

5. Pump grout into the annular space such that the grout head is maintained uniformly around the casing and no visible evidence of water or air is ejected at the top of the grout.

6. Place grout tubes along the circumference of the casing with a minimum of 4 grout tubes per casing. The spacing of the grout tubes must not exceed 4 feet.

7. Extend grout tubes to within 1 foot of the bottom of the casing.

B. If the Engineer lowers the permanent steel casing tip elevation, CIDH concrete pile, including bar reinforcing steel and inspection pipes, must extend to that same elevation.

3.06 PLACING CONCRETE

A. You may construct CIDH concrete piles 24 inches in diameter or larger by excavating and depositing concrete under slurry.

B. Form, finish, and cure portions of CIDH concrete piles shown to be formed under sections 03100 Concrete Forming, 03170 Concrete Finishing and 03300 Cast-In-Place Concrete.

3.07 PLACING CONCRETE UNDER WATER OR SLURRY

A. This section applies if placing concrete under water or slurry.

B. After placing reinforcement and before placing concrete in the drilled hole, if drill cuttings settle out of the slurry, clean the bottom of the drilled hole. Verify that the bottom of the drilled hole is clean.

C. Carefully place concrete in a compact, monolithic mass, using a method that prevents washing of the concrete. Vibrating of concrete is not required.

D. Placing concrete must be a continuous activity lasting no longer than the time specified for each concrete placing activity at each pile in your pile installation plan.

E. The delivery tube system must consist of one of the following:

1. A tremie tube or tubes, each of which is at least 10 inches in diameter, fed by one or more concrete pumps.

2. One or more concrete pump discharge tubes, each fed by a single concrete pump.

F. The delivery tube system must consist of watertight tubes with sufficient rigidity to keep the tube ends always in the mass of concrete placed. If only 1 delivery tube is used to place the concrete, place the tube near the center of the hole. Multiple tubes must be uniformly spaced in the hole.

G. Internal bracing for the steel reinforcing cage must accommodate the delivery tube system. Do not use tremies for piles without space for a 10-inch-diameter tube.

H. During concrete placement, provide a fully operational standby concrete pump at the job site that is adequate to complete the work in the time specified in the pile installation plan.

I. Do not allow concrete to fall into the slurry during concrete placing activities. Cap the delivery tube with a watertight cap, or plug the tube above the slurry level with a good quality, tight fitting, moving plug that will expel the slurry from the tube as the tube is charged with concrete. The cap or plug must be designed to release as the tube is charged.

J. Extend the pump discharge or tremie tube to the bottom of the hole before charging the tube with concrete. After charging the tube with concrete, induce the flow of concrete through the tube by slightly raising the discharge end.

K. During concrete placement:

1. Embed the tip of the delivery tube within 6 inches of the bottom of the hole until 10 feet of concrete has been placed. Maintain the embedment of the tip at least 10 feet below the top surface of the concrete.

2. Do not rapidly raise or lower the delivery tube.

3. Maintain the concrete level at least 10 feet above the piezometric head.

L. If the seal is lost or the delivery tube becomes plugged and must be removed:

1. Withdraw and clean the tube.

2. Cap the tip of the tube to prevent water or slurry from entering.

3. Restart the operation by pushing the capped tube 10 feet into the concrete and then reinitiating the flow of concrete.

M. Maintain a log of concrete placement for each drilled hole. The log must:

1. Show the pile location, tip elevation, dates of excavation and concrete placement, total quantity of concrete placed, length and tip elevation of any casing, and details of any hole stabilization method and materials used.

2. Include an 8-1/2 by 11 inch graph of concrete placed versus depth of hole filled as follows:

a. Label the graph with the pile location, tip elevation, cutoff elevation, and the dates of excavation and concrete placement.

b. Plot the graph continuously throughout concrete placement. Plot the depth of drilled hole filled vertically with the pile tip at the bottom and the quantity of concrete placed horizontally.

c. Take readings at each 5 feet of pile depth, and indicate the time of the reading on the graph.

N. If a temporary casing is used, maintain concrete at a level at least 5 feet above the bottom of the casing. The withdrawal of the casing must not cause contamination of the concrete.

O. The equivalent hydrostatic pressure inside the casing must be greater than the hydrostatic pressure on the outside of the casing.

P. Dispose of material resulting from using slurry.

END OF SECTION

SECTION 05100
METAL FABRICATIONS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for metal fabrications, including minimum requirements for fabricator, and galvanizing.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. A27 Standard Specification for Steel Castings, Carbon, for General Application
2. A36 Standard Specification for Carbon Structural Steel
3. A48 Standard Specification for Gray Iron Castings
4. A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
5. A109 Standard Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled
6. A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
7. A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
8. A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength
9. F3125 Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength
10. A488 Standard Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel
11. A536 Standard Specification for Ductile Iron Castings
12. A563 Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric)
13. A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

14. A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

15. D6386 Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting

16. F436 Standard Specification for Hardened Steel Washers Inch and Metric Dimensions

B. American Welding Society (AWS):

1. D1.1 Structural Welding Code-Steel

C. Society for Protective Coatings (SSPC):

1. SP 1 Solvent Cleaning

2. SP 3 Power Tool Cleaning

3. PA 1 Shop, Field, and Maintenance Coating of Metals

4. Paint 20 Zinc-Rich Coating (Type I – Inorganic and Type II – Organic)

1.03 SUBMITTALS

A. Submit shop drawings showing the following:

1. Sizes, details of fabrication and construction, methods of assembly, locations of hardware, anchors, and accessories, and installation details.

2. Details for manufacturer's items or fabricated metalwork.

3. Field erection details showing cuts, copes, connections, holes, threaded fasteners and welds, both shop and field, by symbols conforming to AWS standards. Indicate net weld lengths.

B. Submit manufacturers' product data. Include application instructions for galvanizing repair product.

C. Metal Fabricator: Submit a list of projects demonstrating a minimum of 5 years of experience in the custom fabrication and construction of metal fabrications and miscellaneous metalwork.

D. Written verification from the manufacturer that the primer is compatible with the finish coats specified in Section 09900, Paints and Coatings.

1.04 DELIVERABLES

A. Welders' Certificates: Submit certification of personnel employed on the work to satisfy the requirements of Clause 4 of AWS D1.1.

1.05 QUALITY ASSURANCE

A. All metal fabrications shall be done by a licensed fabrication shop with a minimum of 5 years of experience in this type of work.

B. Welding including shielded arc process shall conform to the requirements in AWS D1.1 Structural Welding Code

PART 2 - PRODUCTS

2.01 STEEL

A. Plates, Shapes and Bars: ASTM A36, unless otherwise noted

B. Tubing: ASTM A500 or ASTM 501, unless otherwise noted

C. Sheet, Commercial Quality, Galvanized: ASTM A653, G90

D. Strip: ASTM A109

E. Pipe: ASTM A53, Grade B, Schedule 40, black or galvanized, as indicated

F. Steel Castings: ASTM A27 or A48, as indicated

G. Ductile Iron: ASTM A536

H. Perforated steel sheet gratings for bridge walkways must comply with the following:

1. Material for gratings must be structural steel complying with ASTM A1011/A1011M.

2. Perforated sheet gratings shall be fabricated from button-embossed structural steel sheet of minimum 12 gage thickness, with punched holes at apex of buttons for nonslip effect.

3. Grating panels shall be capable of supporting a uniform live load of 150 pounds per square foot and a concentrated load of 1,500 pounds unless indicated otherwise on Contract Drawings.

4. Gratings must be accurately fabricated and free from warps, twists, or defects affecting their appearance or serviceability including:

   a. Ends of all rectangular panels must be square.

   b. Gratings distorted by the galvanizing process must be straightened.

5. After fabrication, gratings and frames shall be hot-dip galvanized after fabrication in accordance with ASTM A123/A123M. Do not paint steel walkway gratings.

I. Bar-Type Gratings:

1. Provide flat-bar type steel gratings of all-welded construction, consisting of bearing bars and secondary bars in rectangular configuration, with flat/plane level traffic surface, hot-dip galvanized after fabrication. Provide gratings with matching hot-dip galvanized steel frames for anchoring in concrete.

2. Notch or frame openings in gratings for penetrations as indicated. Lay out units to allow grating removal without disturbing items penetrating the grating. Provide banding for openings in grating separated by more than four bearing bars, of same material and size as bearing bars.

3. Cut, drill, and fit gratings as required for installation. Notching of bearing bars to provide supports for maintaining elevations will not be permitted.

2.02 FASTENERS

A. Steel Bolts, Anchor Bolts, Nuts, Shear Studs and Threaded Rods: ASTM A307, ASTM A563, and ASTM F436, unless otherwise noted. Bolts and studs, nuts, and washers shall be hot-dip galvanized in accordance with ASTM A153.

B. High Strength Steel Bolts and Nuts: ASTM A325, unless otherwise noted.

C. Anchors, Fasteners, and Accessories: Furnish anchors, fasteners, and associated accessories as required for a complete and finished installation. Anchors, fasteners, and associated accessories shall be stainless steel or hot dipped galvanized.

2.03 MISCELLANEOUS MATERIALS

A. Corrosion-Inhibitive Metal Primer: Conform to SSPC-Paint 20. Verify compatibility of selected primer and finish coats specified in Section 09900, Paints and Coatings.

2.04 CHECKERED SAFETY PLATE

A. When checkered or diamond-pattern steel plate is provided for walkway panels, coat panels with nonslip encapsulated aluminum oxide material bonded or fused to the steel surface. Submit product data and sample for approval.

2.05 IRON CASTINGS

A. Gray: ASTM A48, Class 35B, unless otherwise noted.

2.06 FABRICATION - GENERAL

A. Fabricate miscellaneous metal items with light structural angles, tees, bars, channels, plates, rods, pipes and other rolled steel shapes, as indicated in the Contract Documents and specified herein.

B. Fabricate work true to shape, size and tolerances as indicated on the Contract Drawings and approved shop drawings; with straight lines, square corners or smooth bends; free from twists, kinks, warps, dents, and other imperfections.

Straighten work bent by shearing or punching. There shall be no exposed screws, bolts, and fasteners in the finished work, except as indicated or required.

C. Utilize metal of sufficient thickness and detail assembly and support to provide strength and stiffness sufficient to resist distortion during shipment, handling, installation, and severe service conditions. Exposed edges and ends of metal shall be ground smooth with no sharp edges and with corners slightly rounded. Connections and joints exposed to weather shall be watertight.

D. Form curved work to radii indicated. Furnish bolts, nuts, washers, and other fastening devices required for securing work.

E. For pipe sleeves in concrete construction, provide standard weight, black steel pipe with anchors welded to exterior. Provide sizes as required to accommodate passage of conduits, pipes, ducts and similar items with proper clearance.

F. Fabricate flanges for posts from 3/8-inch minimum thickness plate, and for standoffs from not less than 3/16-inch thickness plate.

G. Metal fabrications shall be prefabricated and preassembled in the factory or shop as far as practicable.

H. Grind off excess metal and make smooth surface welds which will be exposed to view.

2.07 GALVANIZING

A. Steel and ferrous metal items in contact with concrete, on the exterior of buildings, exposed to the weather and moist conditions, and items specifically indicated, shall be galvanized after fabrication. Fabricate items complete or in largest practical sections before galvanizing. Do not field weld fabricated items except where indicated or permitted by the Engineer. Thoroughly clean welded areas prior to galvanizing. Remove weld spatter, burrs, oil, grease and any other deleterious matter that would interfere with the adherence of the zinc.

B. Hot dip galvanize products after fabrication (including shearing, punching, bending, forming, or welding) in accordance with ASTM A123.

C. The weight of zinc coating shall conform to the requirements specified under "Weight of Coating" in ASTM A123, but not be less than 2.0 ounces per square foot of surface area.

D. Shop galvanized metalwork necessitating field welding which in any manner removes original galvanizing shall be restored by field galvanizing repair in accordance with ASTM A780.

E. Hardware items, and bolts and screws for attachment of galvanized items shall be galvanized in accordance with ASTM A153.

2.08 SHOP FINISHING

A. Nongalvanized Metalwork: Shop paint ferrous metal which is not indicated to be galvanized.

1. After fabrication and immediately before shop painting, power-tool clean ferrous metalwork in accordance with SSPC-SP 3 to remove mill scale, rust, grease, oil, and any other foreign matter. Wire brush welds thoroughly.

2. After power-tool cleaning and just before shop painting, wash ferrous metalwork with solvent to remove dust and residue in accordance with SSPC-SP 1.

3. After cleaning and solvent washing, shop paint ferrous metalwork with one coat of corrosion-inhibitive metal primer in accordance with SSPC-PA 1. Material and application shall conform to SSPC-Paint 20.

B. Galvanized Metalwork:

1. Galvanized metal surfaces indicated to be painted shall be prepared for painting in accordance with ASTM D 6386.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install metal fabrications with installation accessories furnished by fabricator as required for complete installation.

B. Install in accordance with approved shop drawings, true and horizontal, perpendicular, or at required angle, as the case may be, level and square with angles and edges parallel with related lines of structure.

C. Install threaded rods used as dowels as specified in Section 03200, Concrete Reinforcing.

D. Field welding, where indicated or allowed, shall conform to the requirements for welding as specified in Section 05200, Structural Steel.

E. Keep field joints to a minimum and concealed. Make field joints strong, rigid, watertight and flush with hairline fit. Grind sharp corners smooth.

F. Grind off excess metal and make smooth surface welds which will be exposed to view.

G. Securely grout posts set in sleeves in conformance to grout manufacturer's instructions. Attach posts not set in sleeves with appropriate fasteners.

H. After installation, damaged prime surfaces shall be prepared as required and touched up with the same primer used for shop primer; leave ready for field painting.

3.02 GALVANIZING REPAIR

A. Galvanized surfaces which have become damaged from welding, handling, or installation shall be repaired immediately after installation with galvanizing repair material in accordance with ASTM A780.

END OF SECTION

SECTION 05200
STRUCTURAL STEEL

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes specifications for structural steel, including steel designated as structural steel on the Contract Drawings.

1.02 REFERENCE STANDARDS

A. American Institute of Steel Construction (AISC):

1. Quality Certification Program for Fabricators

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

1. Manual for Railway Engineering

C. American Society for Nondestructive Testing (ASNT):

1. SNT-TC-1A Recommended Practice

D. ASTM International (ASTM):

1.	A588	Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance
2.	A709	Standard Specification for Structural Steel for Bridges
3.	E94	Standard Guide for Radiographic Examination Using Industrial Radiographic Film
4.	E94	Standard Guide for Radiographic Examination Using Industrial Radiographic Film
5.	E164	Standard Practice for Contact Ultrasonic Testing of Weldments
6.	E165	Standard Practice for Liquid Penetrant Testing for General Industry
7.	E709	Standard Guide for Magnetic Particle Testing
8.	E1032	Standard Practice for Radiographic Examination of Weldments Using Industrial X-Ray Film
9.	A36	Standard Specification for Carbon Structural Steel

10. A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

11. A510 Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel

12. A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

13. A1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

E. American Welding Society (AWS):

1. B1.10 Guide for the Nondestructive Examination of Welds

2. D1.1 Structural Welding Code – Steel

3. D1.3 Structural Welding Code – Sheet Steel

4. D1.5 Bridge Welding Code

5. B2.1 Specification for Welding Procedure and Performance Qualification

6. QC 1 Specification for AWS Certification of Welding Inspectors

F. State of California, Department of Transportation (Caltrans), Standard Specifications:

1. Section 55 Steel Structures

G. Society for Protective Coatings (SSPC):

1. SP 1 Solvent Cleaning

2. SP 3 Power Tool Cleaning

3. SP 10 Near-White Metal Blast Cleaning

4. SP 11 Power Tool Cleaning to Bare Metal

5. PA 1 Shop, Field, and Maintenance Coating of Metals

6. Paint 20 Zinc-Rich Coating (Type I – Inorganic and Type II – Organic)

H. American Association of State Highway and Transportation Officials (AASHTO):

1. M 300 Standard Specification for Inorganic Zinc-Rich Primer

1.03 SUBMITTALS

A. Submit shop drawings with camber calculations conforming to Caltrans Standard Specifications, Section 55-1.01C(2) Shop Drawings, and AREMA Manual, Section 1.1 of Chapter 15. Obtain Engineer's approval at least four weeks in advance of fabrication. The Contractor is responsible for any delay as the result of resubmittal of the shop drawings. Shop drawings shall also show the following:

1. Profiles, sizes, spacing, locations, member identity, methods of assembly, locations of hardware, anchors, and accessories, and erection sequence and details of structural members.

2. Cuts, copes, gussets, holes, openings, fasteners, camber, fabrication and erection tolerances, type of finish, weights of members, and critical clearances. Profiles, sizes, spacing, locations, member identity, methods of assembly, locations of hardware, anchors, and accessories, and erection sequence and details of structural members.

3. Details of connections: bolted and welded. Indicate all shop and field bolts and welds.

4. Details of welded connections with symbols conforming to AWS standards. Indicate size, type, and net lengths of each weld.

5. Investigate stresses caused by the proposed erection procedure. Submit drawings showing details of required temporary supports, staying, and bracing. Include descriptive data and design calculations to illustrate the erection, transportation, and handling procedures, including sequence of erecting and transfer of loads if applicable.

B. Submit a Quality Control Plan (QCP) in accordance with Section 01400, Quality Control and Assurance. The QCP shall be approved by the Engineer prior to fabrication of any structure.

C. Submit a Fracture Control Plan (FCP) in accordance with Chapter 15, Section 1.14 of the AREMA Manual when Fracture Critical Members (FCM) are identified in Contract Documents.

D. Submit a shop schedule to the Engineer and the Contractor-hired Inspection and Testing Agency. The shop schedule shall be provided sufficiently in advance to determine the level of verification inspection required and to arrange for the QC Inspector's attendance. The shop schedule shall include the date fabrication will begin, approximate date it will be completed, and hours of operation. No material shall be fabricated until the shop schedule has been reviewed.

E. Product data for primer including written verification from the manufacturer that the primer is compatible with the finish coats specified in Section 09900, Paints and Coatings.

F. Steel Fabricator: Submit a list of projects demonstrating a minimum of 10 years of experience in the fabrication of structural steel, and verification that the fabricator meets the specified AISC Certification program requirements.

G. Steel Erector: Submit a list of projects demonstrating a minimum of 10 years of experience in the erection of structural steel.

H. Welder Qualifications: Submit copies of qualification test records for each welder, welding operator, and tack welder to be employed in the work. Comply with requirements of AWS D1.1 and D1.5, as applicable. For pipe and tube, comply with requirements of AWS D10.9.

1. Submit welders' identification marks (I.D.) for each welder along with qualifications.

I. Welding Procedure Specifications (WPS): Prior to commencement of welding, submit the procedure specifications that will be used for welding. The WPS shall contain all data indicated in AWS D1.1 and D.15, and any other information necessary to produce welded joints in compliance with this specification. For procedures other than those prequalified in accordance with AWS D1.1, and D1.5, submit a copy of procedure qualification test records in accordance with the qualification requirements of AWS D1.1 and AWS D1.5, as applicable. The WPS shall also include the mitigation of corrosion of welds, including heat treatment and chemical compatibility, as applicable.

1.04 DELIVERABLES

A. Quality Control Deliverables:

1. Certified Mill Test Reports: Submit mill test reports certifying compliance with these specifications, covering chemical and mechanical properties, and destructive and non-destructive test analyses.

2. Certificates of Compliance: Submit Certificates of Compliance to certify that steel materials meet or exceed specified requirements.

3. Welding Records and Data: Submit all radiographs upon completion of fabrication and prior to delivery. Submit certifications that magnetic particle and dye-penetrant inspections have been satisfactorily completed. Submit records of ultrasonic testing upon completion. If field welding is permitted, submit descriptive data for field welding equipment.

4. Test Reports: Submit Charpy V-notch (CVN) test reports as well as all other tests as required in this Section, and the Contract Drawings.

1.05 QUALITY ASSURANCE

A. Submitted shop drawings with calculations substantiating camber and erection procedures shall be prepared, stamped, and signed by a Professional Engineer hired by the Contractor who is currently registered in the State of California.

B. Steel Fabricator:

1. Minimum of 10 years of experience in the fabrication of structural steel, and who participates in the AISC Certification program and is designated an AISC Certified Plant, Category STD.

2. Additionally, a fabricator involved in the fabrication of structural steel for bridges shall be certified under the AISC Quality Certification Program, Category III Major Steel Bridges with Fracture Critical Rating.

C. Steel Erector:

1. Minimum of 10 years of experience in the erection of structural steel.

D. Qualifications of Welders and Welding Procedures: Welders, welding operators, tack welders, and welding procedures shall be prequalified or qualified in accordance with the following AWS Welding Codes and Standards:

1. Structural Steel: AWS D1.1, Section 4, Qualification

2. Steel for Bridges: AWS D1.5, Section 5, Qualification

3. Stud Welding: AWS D1.1, Section 7.6, Stud Application Qualification Requirements

4. Pipe and Tube: AWS D10.9

E. Qualifications of Welding Inspector: Welds to be inspected by the Contractor shall be inspected and certified by a Contractor-employed AWS Certified Welding Inspector (CWI), certified in accordance with AWS QC 1.

F. Qualification of Personnel Performing Nondestructive Testing: Personnel performing nondestructive testing, who are Contractor-employed, shall be qualified and certified in accordance with SNT-TC-1A. Only persons certified for NDT Level I and working under a NDT Level II or Level III person, or persons certified for NDT Level II or Level III may perform nondestructive testing.

G. Qualification of Stud-Connector Manufacturer: Manufacturers' stud base shall be qualified in accordance with Manufacturers' Stud Base Qualification Requirements in AWS D1.1, Section 7.9.

H. Stud Welding Standards: For stud welding, comply with applicable requirements of AWS C5.4.

I. Additional Qualifications for FCP Inspectors: Inspectors and NDT technicians performing inspection under a FCP shall meet the additional requirements in Clause 12 of AWS D 1.5.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Unless otherwise noted in the Contract Documents, the following shall be used for structural steel members:

1. Structural Steel Members: Members shall conform to Caltrans Standard Specifications, Section 55-1.02D, Materials, and AREMA Manual, Chapter 15.

2. Bolts, Nuts, and Washers: Bolts, nuts, and washers shall conform to Caltrans Standard Specifications, Section 55-1.02D, Materials, and AREMA Manual, Chapter 15.

3. Shop Primers: Primers shall conform to SSPC Paint 20. For new steel bridges, use self-curing inorganic zinc-rich primers conforming to AASHTO Designation M300 only. Verify compatibility of shop primer and finish coats specified in Section 09900, Paints and Coatings.

4. Bolts and anchor bolts shall conform to ASTM A325 High Strength bolts unless indicated otherwise.

B. Miscellaneous Steel: Steel items other than structural steel shall conform to Section 05100, Metal Fabrications.

2.02 FABRICATION

A. Fabricate structural steel in accordance with Caltrans Standard Specifications, Section 55-1.02E, Fabrication, and as specified herein.

B. Fabricate structural steel for railroad bridges in accordance with AREMA Manual, Chapter 15.

C. Shop Assembly: Steel members shall be prefabricated and preassembled in the shop as far as practicable. Continuously seal joined members by continuous welds. Grind all exposed welds smooth.

D. For steel bridges, the Contractor must assemble at the fabrication plant the entire structure for inspection by the Engineer. Provide one week minimum notice for the inspection. The assembly is intended to check alignment and fit. The shop assembly connections shall entail:

1. Assembly with minimum of 25 percent bolts and 25 percent pins.

2. Installation of a fastener in at least 10 percent of each connection.

3. Insertion of a bolt or pin into every bolt hole to ensure proper bolt hole alignment.

4. No matching holes shall be reamed.

5. All parts of the structure shall be match marked for field erection.

E. Field Connections: Provide bolts for all field connections except where indicated or permitted by the Engineer.

1. Use high-strength bolts unless indicated or specified otherwise.

2. If structural steel details shown on the Contract Drawings are not compatible with selected erection procedures, submit proposed modifications for review.

F. Field welding, where indicated or permitted by the Engineer, shall be performed as herein specified for shop welding.

2.03 SHOP FINISHING

A. Interior, Non-Corrosive Applications:

1. After fabrication and immediately before shop painting, wash structural steel materials with solvent to remove dust and residue in accordance with SSPC-SP 1.

a. Structural Steel Materials not Exposed to the Public: Power-tool cleaned in accordance with SSPC-SP 3 to remove mill scale, rust, grease, oil, and any other foreign matter.

b. Structural Steel Materials Exposed to Public View: Blast cleaned in accordance with SSPC-SP 10 or power-tool cleaned in accordance with SSPC-SP 11 to remove all visible mill scale, rust, grease, oil, and any other foreign matter.

2. If materials are not painted immediately after cleaning then those materials shall be washed with solvent to remove dust and residue in accordance with SSPC SP 1.

3. After preparation, shop paint steel materials with one coat of corrosion-inhibitive metal primer in accordance with SSPC PA 1. Materials and application shall conform to SSPC-Paint 20.

B. Exterior Applications:

1. Steelwork to be Exposed to Weather: Blast cleaned in accordance with SSPC-SP 10, Near White Blast Cleaning, or power-tool cleaned in accordance with SSPC-SP 11, Power Tool Cleaning to Bare Metal. For new steel bridges, cleaning shall be in accordance with SSPC-SP 10.

2. After cleaning, solvent wash in accordance with SSPC-SP 1, and shop paint steelwork in accordance with SSPC-PA 1. Materials and application shall conform to SSPC-Paint 20. For new steel bridges, only self-curing inorganic zinc-rich primers conforming to AASHTO Designation M300 shall be used.

2.04 SHOP WELDING

A. Perform shop welding as indicated in accordance with the AWS D1.1 and AWS D1.5, as applicable to the work.

B. Welders shall mark adjacent to completed welds their welder I.D., using metal stamp, metal engraving, keel, paint stick, or other appropriate marking material.

C. Welding of stud shear connectors shall conform to AWS D1.1, Section 7, Stud Welding, AWS C5.4, and the stud manufacturer's instructions.

2.05 INSPECTIONS AND TESTS BY THE CONTRACTOR

A. Visual Inspection: All welds for structural steel and structural steel for bridges shall be visually examined in accordance with AWS D1.1, Sections 6 and 7.8, as applicable. Quality of welds and standards of acceptance shall be in accordance with AWS D1.1, Section 6.9.

B. Nondestructive Testing: Nondestructive testing shall conform to AWS B1.10.

C. Radiographic Testing: Radiographic testing of welds shall conform to AWS D1.1, Section 6.12 and ASTM E94, ASTM E142, and ASTM E1032, as applicable. Complete joint penetration groove welds shall be tested as follows:

1. 20 percent with thickness equal to or less than 3/4 inch

2. 50 percent with thickness greater than 3/4 inch and equal to or less than 1-1/2 inches

3. 100 percent for thickness greater than 1-1/2 inches

D. Ultrasonic Testing: Ultrasonic testing of welds shall conform to AWS D1.1, Section 6.13, and ASTM E164, as applicable. Complete joint penetration groove welds not accessible for radiographic testing shall, with Engineer's approval, be subjected to ultrasonic testing. The extent shall be the same as specified for radiographic testing.

E. Magnetic Particle Inspection: Magnetic particle inspection of welds shall conform to ASTM E709. Complete and partial joint penetration groove welds and fillet welds shall be inspected as follows:

1. 25 percent of complete joint penetration groove welds of tee and corner joints.

2. 20 percent of partial joint penetration groove welds and fillet welds.

F. Liquid Penetrant Inspection: Liquid dye penetrant inspection of welds shall conform to ASTM E165. Liquid penetrant inspection shall be used for detecting discontinuities that are open to the surface.

G. Inspections for Bridge Structural Steel Welding: Inspect welds in accordance with AWS D1.5, Section 6.7 Nondestructive Testing. In addition, perform the following nondestructive testing:

1. 10% of fillet welds on bearing stiffeners shall be inspected by the ultrasound method.

2. At least 10 percent of all welds on secondary members shall be inspected by the ultrasonic or magnetic particle method.

a. If any defects are found, 100 percent inspection by the ultrasonic or magnetic particle shall be required.

3. Conduct additional inspection of welds for Fracture Critical Members in accordance with Clause 12 of AWS D1.5.

4. Time delay prior to NDT of weld repairs to groove welds of ASTM A588 or ASTM A709 material over 2 inches in thickness subject to tensile stress, shall be 16 hours minimum.

H. Test Results: Test result information shall be forwarded to the Engineer immediately after test results are available, stating the acceptance or rejection of fabricated components, so that repairs and reinspection or testing may be performed as soon as possible.

I. Repairs: Unacceptable welds shall be repaired in accordance with AWS D1.1 and D1.5 as applicable. Repaired or corrected welds shall be reinspected or retested as specified for the original weld.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Erection:

1. Allow for erection loads, and for sufficient temporary bracing to maintain the structure safely plumb and in true alignment until completion of erection and installation of permanent bracing.

2. Do not field cut or alter structural members without prior approval of the Engineer.

3. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.

4. Coordinate the installation of structural steel with the installation of miscellaneous metals to minimize the requirement for field cutting, alteration, temporary bracing, and redundant operations during erection.

B. Erection Tolerances: Maximum offset from true alignment shall be 1/4 inch.

3.02 FIELD FINISH

A. Refer to Section 09900, Paints and Coatings, for field finish for work of this Section.

1. After installation or erection of structural steelwork, abraded areas, field bolts, and welds shall be touched up and spot painted with corrosion-inhibitive primer. Field welds shall be thoroughly wire-brushed or disc-sanded prior to touch-up painting.

2. Apply 2 coats of Heavy Duty Exterior Finish Coats in accordance with Section 09900 Article 2.02.E. Finish color shall be Federal Standard 595, No. 36492, Gray.

3.03 BOLTED CONNECTIONS

A. Connections made with high-strength bolts shall be tensioned as slip-critical Class B as designated in AREMA Table 9-2, Chapter 15.

B. Contractor shall provide a tension calibrating device on site to check power wrenched or a calibrated manual torque wrench. Equipment shall be tested in the presence of the Engineer. Bolts shall be tightened to the required tension by use of the turn-of-nut tensioning method per AREMA Chapter 15, Section 3.2.2. Bolt tensions shall be checked at locations selected by the Engineer. Checking of bolt tensions shall be done by the Contractor in the presence of the Engineer.

C. Bolts shall be placed so that the heads are on the outside (visible on exterior) surface of the members unless otherwise approved by the Engineer, except where bolts are vertical, and heads of bolts shall be placed above nuts.

END OF SECTION

SECTION 05500

PEDESTRIAN EXIT GATES AND GUARDRAIL

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for pedestrian exit gates and guardrailing for installation at at-grade crossings. The locations of this installation include vehicular grade crossings, and pedestrians only at passenger stations crossings and at rail crossings.

B. The proper functioning of the exit gates requires high level of workmanship in fabrication and installation of hinges and gates.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. A36 Standard Specification for Carbon Structural Steel

2. A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

3. A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

4. A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

B. American Welding Society (AWS):

1. D1.1 Structural Welding Code-Steel

1.03 SUBMITTALS

A. Submit shop drawings showing member sizes, details of fabrication and construction, methods of assembly, and installation details. Adjust guardrailing design based on site conditions to allow for slope variation on sidewalk.

B. Submit shop drawings for the fabricator's hinges and gates.

C. Submit manufacturers' product data. Include application instructions for galvanizing repair product.

1.04 DELIVERABLES

A. Welders Certificates: Submit certification of personnel employed on the work to satisfy the requirements of Clause 4 of AWS D1.1.

1.05 QUALITY ASSURANCE

A. Welding including shielded arc process shall conform to the requirements in AWS D1.1 Structural Welding Code.

B. All components (hinges, posts, gates, guardrailing) in this Section shall be fabricated in shop for desired quality. Use only well experienced welders and fitters.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Hinges: DOM (Drawn Over Mandrel) steel with minimum yield strength of 60 ksi.

B. Steel Plate and Miscellaneous Items: ASTM A36, except as otherwise indicated on the Contract Drawings.

C. Steel Pipe for posts, gates and guardrailing: Seamless steel pipe, conforming to ASTM A53, Type S, Grade A, standard weight, nominal size as shown on the Contract Drawings.

D. Brackets, Bolts, Threaded Studs, Nuts, Washers and Other Fittings: Galvanized, commercial quality structural steel, except that standard steel pipe fittings may be used where shown on the Contract Drawings. For mounting of signage to the gates: use only SS 316 hardware as shown on the Caltrain Standard Drawing.

E. Mechanical expansion anchors for attaching the railing to supporting concrete members: Concrete anchorage devices as specified in Caltrans Standard Specifications, Section 75-3, "Miscellaneous Bridge Metal."

F. Non-Shrink Grout: Master Builders "Embeco," Sonneborn Bldg Products, Inc "Ferrolith G," Halemite Manufacturing Company "Por Rok," or Engineer approved equal.

G. Hot Process Field Galvanizing (for repairs): Galv, Galvalloy, Galvweldalloy, or Engineer approved equal.

2.02 FABRICATION

A. Workmanship: Accurately fabricate hinges, gates and posts neat and rigid in shop for desired quality. Set components accurately in position, leveled, squared and aligned.

B. Mock-up Set: Fabricate in shop a complete mock-up set for Engineer's approval. Approved set serves as the standard of quality for other sets.

C. Guardrailing: Weld railings, continuous as detailed. Fabricate welded pipe items with flush welded construction throughout, except where sleeve joints or other mechanical joints for field connection or job requirements are necessary.

D. Heat railing and make radius bends to produce uniform curvature without distortion. Shape curved sections on true radius without buckle, dent, kinks or

flattened sections. Cope intersections; continuously weld and grind welds smooth. Return rail ends to 1/4 inch clearance and weld plug over open end.

E. Sleeves for Anchoring Railing Posts in Concrete: Galvanized standard pipe sleeves with welded-on bottom plates or 24 gage galvanized sheet metal sleeves with bottoms. Sleeve diameter shall be at least 3 times the outside diameter of the rail posts.

F. Grind off excess metal and make smooth surface welds which will be exposed to view.

2.03 WELDING

A. Use electric shielded arc process conforming to the requirements of AWS D1.1.

1. Use E7018 low hydrogen electrodes for A36 steel.

2.04 GALVANIZING

A. Fabricate units complete or in largest practical sections before galvanizing. Thoroughly clean welded areas prior to galvanizing. Remove weld spatter, burrs, oil, grease and any other deleterious matter that would interfere with the adherence of the zinc.

B. Hot dip galvanize exterior railing, gates, and attached metal components after fabrication (including shearing, punching, bending, forming, or welding) in accordance with ASTM A123.

C. The weight of zinc coating shall be not less than 2.0 ounces per square foot of surface area.

D. After galvanizing, all elements of the railing shall be free of fins, abrasions, rough or sharp edges and other surface defects and shall not be kinked, twisted or bent. If straightening is necessary, straighten using methods approved by the Engineer. Kinks, twists, or bends in railing elements may be cause for rejection of the railing elements.

2.05 FINISHES

A. Gates, gate posts and hinges and all attached metal components shall be painted in accordance with Section 09900, Paints and Coatings. Apply 2 coats of Heavy Duty Exterior Finish Coats in with Section 09900 Article 2.02.E. Color shall be Federal Safety yellow FS 33538.

B. Paint guardrailing if indicated in Contract Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install work straight and plumb with members anchored, secure and fasten together in accurate position, neat, rigid, level, square, straight and plumb.

B. Keep field joints to a minimum and concealed to greatest practical extent. Make field joints strong, rigid, watertight and flush with hairline fit. Ease sharp corners.

C. Securely posts set in sleeves with non-shrink grout in accordance with grout manufacturer's instructions.

D. Where posts are not set in sleeves, mechanically secure posts to wood or steel surfaces with fasteners as shown on the Contract Drawings or in accordance with approved shop drawings.

E. Repair abraded or damaged galvanized surfaces with hot process field galvanizing in accordance with ASTM A780 and manufacturer's published instructions.

3.02 SITE TOLERANCES

A. Gates shall swing open freely and close return such that the gate stops meet tightly.

B. Install guardrailing posts vertical within a tolerance not to exceed 0.02-foot in 10 feet.

END OF SECTION

SECTION 07150

POLYMERIC SHEET WATERPROOFING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for polymeric waterproofing membrane on bridge decks, as well as for asphalt plank over membrane on bridge decks.

1.02 REFERENCE STANDARDS

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

1. Manual for Railway Engineering Chapter 8, Part 29, Waterproofing

B. ASTM International (ASTM):

1. D146 Standard Test Methods for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing

2. D882 Standard Test Method for Tensile Properties of Thin Plastic Sheeting

3. D1970 Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection

4. D4258 Standard Practice for Surface Cleaning Concrete for Coating

5. D4263 Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method

6. E96 Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials

7. E154 Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover

8. D517 Standard Specification for Asphalt Plank

1.03 SUBMITTALS

A. Product Data: Technical data and general recommendations for types of waterproofing required.

1. Data for surface primer, flexible flashings, joint cover sheet, and joint and crack sealants, with temperature range for application of waterproofing membrane.

2. Installation instructions indicating special procedures and perimeter conditions requiring special attention. Include preparation instructions for existing deck surfaces.

B. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.

C. Sample:

1. Membrane waterproofing and auxiliary materials mounted on plywood

2. Asphalt Plank

1.04 DELIVERABLES

A. Certifications of Compliance:

1. Certification by waterproofing materials manufacturer stating products supplied comply with local VOC and environmental regulations.

2. Certifications by asphalt plank materials manufacturer that materials meet specified requirements.

B. Documentation that manufacturer of asphalt plank has successfully furnished such material to Class 1 Freight or Commuter Railroads. This does not include transit or light rail.

C. Test Reports: From a qualified independent testing agency evidencing compliance of waterproofing with requirements and other physical properties reported by manufacturer based on comprehensive testing of products according to current standard test methods within previous 5 years.

D. Field Quality Control Reports.

1.05 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain primary waterproofing materials from a single manufacturer to the greatest extent possible. Provide secondary materials recommended by manufacturer of primary materials.

B. Installer Qualifications: Firm with minimum of 5 years documented experience showing satisfactory service performance and acceptable to primary waterproofing materials manufacturer.

C. The suppliers of asphalt plank material shall have successfully furnished such material to Class 1 Freight or Commuter Railroads. This does not include transit or light rail.

D. Provide services of waterproofing manufacturer's field representative to observe and approve surface preparation.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver primary waterproofing materials to steel fabrication shop or job site, as applicable. Manufacturer's labels shall include the following information:

1. Product name and description (generic product classification)

2. Batch number under which product was produced

3. National standards with which the product complies

4. Application instructions

B. Store materials in clean, dry, protected location, and away from direct sunlight.

C. Asphaltic panels shall be stored so as to prevent warping and breaking.

1.07 PROJECT CONDITIONS

A. Weather: Proceed with waterproofing and associated work when existing and forecasted conditions permit work to be performed in accordance with manufacturer's recommendations and warranty requirements.

B. Temperature: Maintain ambient temperatures above 40 degrees F for 24 hours before and during application and until liquid or mastic accessories have cured.

C. Environmental Conditions: Apply waterproofing within range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate. Do not apply waterproofing in rain, fog, or mist.

D. Maintain adequate ventilation during preparation and application of waterproofing materials.

PART 2 - PRODUCTS

2.01 WATERPROOFING SYSTEM

A. Manufacturer: MEL-DEK, Deck Waterproofing System, as manufactured by W. R. Meadows, Inc, or Engineer approved equal. Waterproofing system shall be able to withstand dynamic placement of hot asphalt overlays.

B. Waterproofing membrane shall be composed of a two layer composite sheet consisting of 53 mil polymeric membrane on a shirk-resistant, heavy duty 12 mil polypropylene woven carrier fabric with an overall thickness of 65 mils. Membrane shall conform to the following properties:

Test Method	Performance
Tensile Strength, ASTM D 882 Warp Fill	 90 lbs/in (1.6 kg/mm) 90 lbs/in (1.6 kg/mm)
Elongation, ASTM D 882 Polymeric Membrane Fabric, Warp Fabric, Fill	 410 percent 35 percent 45 percent
Puncture, ASTM E 154	275 lbs (122 kN)
Flexibility, ASTM D 146 180 degrees Bend, 1/4 inch (6.35mm) mandrel @ - 26 degrees F (- 32 degrees C)	Pass
Water Vapor Permeance, ASTM E-96, Water Method	0.03 Perms
Water Absorption, ASTM D 1970	0.06 percent

C. Auxiliary Materials: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with waterproofing sheet membrane.

1. Primer: Liquid primer recommended by manufacturer of sheet waterproofing material for substrate.

2. Mastic, Adhesives, and Tape: Liquid mastic and adhesives, and adhesive tapes recommended by waterproofing manufacturer.

3. Asphalt Plank: Type I, b, conforming to the requirements of ASTM D517, plain type, applied in minimum thickness of one inch using two layers with joints staggered; or asphaltic panels conforming to the AREMA Manual, Chapter 8, Part 29, applied in minimum thickness of one inch using two layers with joints staggered.

2.02 ASPHALT PLANK

A. Asphalt plank shall conform to the following requirements when tested in accordance with ASTM D517:

1. Absorption: The absorption of the plank shall not exceed 1.0% by weight

2. Brittleness: At least 80% of the specimens tested shall not show any detrimental cracking

3. Hardness: The hardness of the plank shall meet the following requirements

Temperature (Fahrenheit)	Load (Pounds)	Penetration (Mils)
77	30	< 65

4. Dimensions: Asphalt plank shall have the dimensions specified or shown on the plans. Tolerances of 1/16 inch thickness, 1/8 inch width and 1/8 inch length will be permitted.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions under which waterproofing systems will be applied, with Installer present, for compliance with requirements. Proceed with work after substrate construction, openings, and penetrating work have been completed and areas are free of standing or running water, and frost. Verify deck is dry, smooth, and free from sharp or rough edges, honeycombing, rock pockets, depressions, and projections.

1. Verify substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.

2. Correct unsatisfactory conditions prior to proceeding with installation.

B. Existing Decks: Have the necessary materials, equipment, and personnel on stand-by during the cleaning of deck and for making a rapid assessment and repairs to the deck if found to be in a damaged or deteriorated condition.

3.02 SURFACE PREPARATION

A. Clean, prepare, and treat substrate according to manufacturer's written instructions. Provide clean, dust free, and dry substrate for waterproofing application.

1. Clean in accordance with the waterproofing manufacturer's recommendation and requirements for the products to be installed.

2. The use of water to clean the deck will not be allowed.

B. Existing Deck Surfaces: Prepare surface to a smooth, sound, monolithic condition, free of voids, spalled areas, sharp protrusions, and loose aggregate as instructed or approved by the waterproofing manufacturer in writing. Remove old membrane, oil grease or other contaminants.

C. Mask off adjoining surfaces not receiving primer and waterproofing to prevent spillage affecting other construction.

D. Remove grease, oil, form release agents, paints, and other penetrating contaminants from surface.

E. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.

F. Prepare, fill, prime, and treat joints and cracks in substrate. Remove dust and dirt from joints and cracks according to ASTM D 4258.

1. Install 28 inch wide additional membrane strip and 20 inch wide 16 gauge galvanized sheet metal cover plate centered over construction, control joints, and expansion joints, and cracks less than 1/4 inch in width.

2. In addition to the requirements specified above for joints and cracks less than 1/4 inch in width, all joints greater than 1/4 inch shall have a 1/2 inch

by 10 inch wide galvanized steel plate installed prior to the 16 gauge sheet metal plate and the membrane strip.

G. Inside Corners: Prepare, prime, and treat inside corners according to waterproofing manufacturer's written instructions.

1. Install membrane strip centered over vertical inside corners. Install 3/4 inch fillets of liquid membrane on horizontal inside corners and as follows:

a. At footing to wall intersections, extend liquid membrane each direction from corner or install membrane strip centered over corner.

b. At deck to wall intersections, extend sheet membrane flashing onto deck waterproofing and to finished height of sheet flashing.

H. Outside Corners: Prepare and treat outside corners according to waterproofing manufacturer's written instructions.

1. Install strip of membrane 12 inches wide, centered over corner.

I. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions according to waterproofing manufacturer's written instructions.

3.03 SHEET APPLICATION

A. Install waterproofing membrane according to waterproofing manufacturer's written instructions.

1. Apply primer to substrate at required rate and allow to dry. Limit priming to areas covered by waterproofing membrane in same day. Re-prime areas exposed for more than 24 hours.

2. Apply from low point to high point in both the longitudinal and transverse directions.

a. In the transverse direction, overlap in shingle fashion 2-1/2 inch after removing the white polyethylene strip that exposes the 3/4 inch rubberized asphalt.

b. In the longitudinal direction, overlap six (6) and seal with manufacturer's recommended mastic.

3. Once positioned, immediately hand rub waterproofing membrane onto the substrate. Follow by a pressure-applied roll-pressing of the complete surface.

4. Seal all terminations with manufacturer's recommended pointing mastic.

5. Install sheet membrane and auxiliary materials to tie in adjacent waterproofing.

6. Repair tears, voids, and lapped seams in waterproofing not meeting requirements. Slit and flatten fishmouths and blisters. Patch with sheet membrane extending 6 inches (150 mm) beyond repaired areas in all directions.

3.04 ASPHALT PLANK

A. After the membrane waterproofing has been inspected and accepted by the Engineer, install asphalt plank with adhesive in accordance with the applicable requirements of AREMA Manual, Chapter 8, Part 29 and with the manufacturer's installation instructions and recommendations, for protection from subsequent construction operations and ballasted track installation.

B. Install asphalt plank directly on the waterproofed deck cleaned of all debris and dust. Remove rough or uneven areas by grinding until the surface is acceptable and re-waterproof as required. Obtain Engineer's inspection and approval of intersections of ballast plate and recesses prior to installing the asphalt planks.

C. Asphalt plank damaged during subsequent construction operations and activities shall be properly repaired or replaced immediately.

3.05 FIELD QUALITY CONTROL

A. Field inspections and sampling and testing materials to verify that work of this Section conforms to the specified requirements shall be performed by the independent Inspection and Testing Agency hired by the Contractor.

B. After surface preparation and before commencing waterproofing installation, waterproofing manufacturer field representative shall provide a written statement of the suitability the deck to receive the waterproofing.

C. Correct deficiencies in or remove waterproofing that does not comply with requirements, repair substrates, reapply waterproofing, and repair sheet flashings.

1. Repair defects and make further repairs until waterproofing installation is watertight.

D. Additional testing shall be performed to determine compliance of corrected work with requirements.

3.06 PROTECTION

A. Protect waterproofing from damage and wear during application and remainder of construction period, according to manufacturer's written instructions.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

C. Remove ballast mats contaminated with silt and debris, clean and reinstall or replace with new materials.

END OF SECTION

SECTION 07160

COLD LIQUID-APPLIED WATERPROOFING SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for placement of the multi-layered cold liquid-applied membrane waterproofing system on new steel bridge decks and as shown on the Plans. The work shall include furnishing all labor, materials, tools, equipment and incidentals necessary to install the waterproofing system as specified herein.

1.02 REFERENCE STANDARDS

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

1. Manual for Railway Engineering Chapter 8, Part 29, Waterproofing

B. ASTM International (ASTM):

1. C836 Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course

2. D638 Standard Test Method for Tensile Properties of Plastics

3. D4541 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

4. D4258 Standard Practice for Surface Cleaning Concrete for Coating

5. E96 Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials

C. Society for Protective Coatings (SSPC):

1. PA 2 Procedure for Determining Conformance to Dry Coating Thickness Requirements

1.03 SUBMITTALS

A. Product Data:

1. Product data for waterproofing coating system include primer, flexible flashings, joint cover sheet, and joint and crack sealants as applicable. Include test data demonstrating conformance with the provisions as specified herein.

2. Installation instructions indicating special procedures and perimeter conditions requiring special attention. Include preparation instructions for deck surface.

B. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.

C. Quality Control Plan: Include procedures and requirements for surface preparation, waterproofing material application, inspections, and record keeping.

1.04 DELIVERABLES

A. Certifications of Compliance:

1. Certification by waterproofing materials manufacturer stating products supplied comply with local VOC and environmental regulations.

2. Certifications by materials manufacturer that materials meet specified requirements.

B. Documentation that manufacturer of asphalt plank has successfully furnished such material to Class 1 Freight or Commuter Railroads. This does not include transit or light rail.

C. Test Reports: From a qualified independent testing agency evidencing compliance of waterproofing with requirements and other physical properties reported by manufacturer based on comprehensive testing of products according to current standard test methods within previous 5 years.

D. Field Quality Control Reports.

1.05 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain primary waterproofing materials from a single manufacturer to the greatest extent possible. Provide secondary materials recommended by manufacturer of primary materials.

B. Manufacturer Qualifications: The manufacturer must have a minimum 5 years' experience providing similar coating systems to bridges on Class I Freight or Commuter Railroads. This does not include transit or light rail.

C. Installer Qualifications: The installer must hold a current Authorized Contractor Certificate from the manufacturer.

D. Provide services of waterproofing manufacturer's field representative to observe and approve surface preparation.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Store materials in clean, dry, protected location, and in accordance with manufacturer's instructions.

1.07 PROJECT CONDITIONS

A. Weather: Proceed with waterproofing and associated work when existing and forecasted conditions permit work to be performed in accordance with manufacturer's recommendations and warranty requirements.

B. Temperature: Install system when air and substrate temperature is above 40°F and substrate is above dew point, or when the range of ambient and substrate temperatures are within values recommended by waterproofing manufacturer.

C. Maintain adequate ventilation during preparation and application of waterproofing materials.

PART 2 - PRODUCTS

2.01 WATERPROOFING SYSTEM

A. Waterproofing System: The deck waterproofing shall be an elastomer coating system suitable for metal surfaces. The coating system shall consist of a primer and a spray-applied, fast cure deck membrane covered by a seamless, spray-applied, high build, deck membrane protection course. The following waterproofing systems or Engineer approved equal shall be used.

1. Bridge Preservation – Bridge Deck Membrane with Integrated Ballast Mat.

2. D.S. Brown - Deckguard with Liquid Ballast Mat.

B. Waterproofing Membrane Coat.

1. Waterproofing membrane coat shall be a rapid curing, two-component, 100% solids, spray-applied elastomer coating material.

2. The minimum thickness of waterproofing membrane coat applied shall be 80 mils.

3. Waterproofing membrane physical properties shall conform to AREMA Ch. 8, Table 8-29-3 and as specified below:

4. Provide manufacturer recommended primer for concrete bridge surfaces.

C. Membrane Protection Course.

1. The membrane protection course shall be a rapid curing, 100% solids, spray-applied coating material integrated with a protective elastomeric filler or layer.

Property / Test Method	Performance
Crack Bridging Test (1/8") - ASTM C836	10 Cycles @ -26°C
North American Ballast Impact Test at 2 Million Cycles	No Damage
Elongation - ASTM D638	>80%
Tensile Strength - ASTM D638	>930 psi
Adhesion to Steel - ASTM D4541	>290 psi
Adhesion to Concrete - ASTM D4541	>100 psi
Water Vapor Transmission, ASTM E96, Procedure B or BW	Equal to or Less than 0.2 perms

2. Minimum thickness of membrane protection course shall be installed as recommended by each individual manufacturer.

3. The membrane protection course shall integrate seamlessly with the underlying deck membrane coat.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions under which waterproofing systems will be applied, with Installer present, for compliance with requirements. Proceed with work after substrate construction, openings, and penetrating work have been completed and areas are free of standing or running water, and frost. Verify deck is dry, smooth, and free from sharp or rough edges, honeycombing, rock pockets, depressions, and projections.

1. Verify substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.

2. Correct unsatisfactory conditions prior to proceeding with installation.

B. Existing Decks: Have the necessary materials, equipment, and personnel on stand-by during the cleaning of deck and for making a rapid assessment and repairs to the deck if found to be in a damaged or deteriorated condition.

3.02 SURFACE PREPARATION

A. Clean, prepare, and treat substrate according to manufacturer's written instructions. Provide clean, dust free, and dry substrate for waterproofing application.

1. Clean in accordance with the waterproofing manufacturer's recommendation and requirements for the products to be installed.

2. The use of water to clean the deck will not be allowed.

B. Existing Deck Surfaces: Prepare surface to a smooth, sound, monolithic condition, free of voids, spalled areas, sharp protrusions, and loose aggregate as instructed or

approved by the waterproofing manufacturer in writing. Remove old membrane, oil grease or other contaminants.

C. Mask off adjoining surfaces not receiving primer and waterproofing to prevent spillage affecting other construction.

D. Remove grease, oil, form release agents, and other penetrating contaminants from surface.

E. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.

F. Prepare, fill, prime, and treat joints and cracks in substrate according to manufacturer's instructions as applicable. Remove dust and dirt from joints and cracks according to ASTM D 4258.

1. Install 28 inch wide additional membrane strip and 20 inch wide 16 gauge galvanized sheet metal cover plate centered over construction, control joints, and expansion joints, and cracks less than 1/4 inch in width.

2. In addition to the requirements specified above for joints and cracks less than 1/4 inch in width, all joints greater than 1/4 inch shall have a 1/2 inch by 10 inch wide galvanized steel plate installed prior to the 16 gauge sheet metal plate and the membrane strip.

3.03 APPLICATION

A. Apply waterproofing membrane according to waterproofing manufacturer's written instructions.

1. Metal surfaces must be dry, rust-free, and have proper SSPC profile and preparation as recommended by the manufacture.

2. Apply primer as applicable. Allow primer to go tack-free before spraying deck membrane coat. Reapply primer if it has set for more than 18 hours.

3. Spray base coat of deck membrane to required thickness.

4. Retouch coat by filling low spots or areas with inadequate thickness. Spray additional deck membrane coats to achieve specified deck membrane thickness. Retouch as required.

5. Install deck membrane protection course per manufacturer's recommendations.

3.04 FIELD QUALITY CONTROL

A. Perform dry film thickness tests of the deck membrane coat in accordance with SSPC-PA2 as required. Deck membrane gels too rapidly to perform wet film test.

B. Spray equipment shall be calibrated and tested to a stroke count per gallon of product sprayed to facilitate thickness assurance.

C. Ultrasonic testing is usually accurate to +/- 5%.

D. Repair destructive testing areas of the deck membrane by re-spraying or by filling with special two component gun grade material provided by manufacturer.

3.05 PROTECTION

A. Protect waterproofing from damage and wear during application and remainder of construction period, according to manufacturer's written instructions.

B. Clean spills and oversprays as they occur. Use cleaning agents and procedures recommended by manufacturer.

C. Place ballast after deck membrane protection course has cured for a minimum of 1 hour.

END OF SECTION

SECTION 07250

JOINT SEALANTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for joint sealants and accessories.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. C920 Standard Specification for Elastomeric Joint Sealants

2. C1193 Standard Guide for Use of Joint Sealants

3. D1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

1.03 SUBMITTALS

A. Shop Drawings: Submit details to show installation and interface between sealants and adjacent work.

B. Product Data: Submit materials list of items proposed to be provided under this Section and manufacturer's specifications and other data needed to prove compliance with the specified requirements.

C. Samples:

1. Submit color samples including project specific non-standard colors developed by the manufacturer as required, matching the indicated color for each sealant type for initial selection. In addition, submit the manufacturer’s standard color charts for initial selection.

2. Submit for final approval cured color samples for each sealant type illustrating selected colors.

D. Manufacturer's Installation Instructions: Submit manufacturer’s published installation procedures. Include instructions for completing sealant intersections when different materials are joined.

E. Manufacturer's Certificate:

1. Certify products are suitable for intended use including hardness appropriate for pedestrian traffic areas and products meet or exceed specified requirements.

2. Certify applicator is approved by manufacturer.

3. Submit letter signed by a representative of the manufacturer confirming the compatibility of joint-shaping materials with sealant and release tapes with sealant.

4. Certify joint backing is that recommended by the sealant manufacturere to suit joint sealant application.

1.04 DELIVERABLES

A. Qualifications Data: Submit applicator's qualifications, including reference projects of similar scope and complexity, with current phone numbers and contact names of architects and owners for verification.

B. Operation and Maintenance Data: Submit data including recommended inspection intervals and instructions for repairing and replacing failed sealant joints.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience.

B. Applicator Qualifications:

1. Company specializing in performing work of this section with minimum three years documented experience, minimum three successfully completed projects of similar scope and complexity, and approved by manufacturer.

2. Designate one individual as project foreman who shall be on site at all times during installation.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store primers and sealants in accordance with the manufacturers' printed recommendations and the following: Store in cool dry location with ambient temperature range of 60 to 80 degrees F.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Install primers and sealants in accordance with ACI 504R and the manufacturer's printed recommendations. Do not install primers or sealants when atmospheric temperatures or joint surfaces temperatures are below 40 degrees F.

1.08 WARRANTY

A. Submit signed copies of the warranties against adhesive and cohesive failure of sealant and against infiltration of water and air through sealed joint for period of 3 years from date of completion. Include the following warranties:

1. Manufacturer's warranty covering sealant materials

2. Applicator's warranty covering workmanship

PART 2 – PRODUCTS

2.01 GENERAL

A. Like items of materials shall be supplied by one manufacturer to achieve standardization for appearance, maintenance, and replacement throughout the project, unless otherwise approved by the Engineer.

B. Sealant characteristics shall be as follows:

1. Uniform, homogeneous

2. Free from lumps, skins, and coarse particles when mixed

3. Non-staining, non-bleeding

C. Unless specifically noted, sealant color shall match the adjoining area.

D. Use as few sealant types as possible to meet the requirements of the Work.

E. Joint sealants are specified in other Sections, including the following:

1. Section 02700, Station Platforms, Sidewalks, Curbs and Gutters

2. Section 03150, Concrete Accessories: Includes expansion joints, joint fillers, and sealers

3. Section 09650, Detectable Warning Tactiles: Sealant installed with panels

4. Section 09655, Detectable Guide Tactiles: Sealant installed with tiles

2.02 SEALANT TYPES

A. Type A: Multi-Component Urethane: ASTM C920, Type M, Grade NS, Class 25 or Class 50 as required for application; Uses NT, M, A, and O; two component, chemical curing, non-staining, non-bleeding, color as selected.

B. Type B: Multi-Component Self-Leveling Urethane: ASTM C920, Type M, Grade P or NS as appropriate for application, Class 25, Uses T; self-leveling, multi-component, chemical curing, non-staining, non-bleeding, color as selected.

2.03 ACCESSORIES

A. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

B. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

C. Joint Backing: Round foam rod compatible with sealant; oversized 25 to 50 percent larger than joint width; recommended by sealant manufacturer to suit application.

D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

E. Masking Tape: Non-staining, non-absorbent tape product compatible with joint sealants and adjacent joint surfaces.

F. Joint Filler: Pre-molded asphalt impregnated felt conforming to ASTM D1751.

PART 3 – EXECUTION

3.01 GENERAL

A. Use of more than a single type of sealant for the same joint will not be permitted.

B. Horizontal and Sloping Joints of up to one (1) Percent Slope: Self-leveling joint sealant or nonsag sealant shall be used.

C. Joints steeper than 1 Percent Slope, Vertical Joints, and Overhead Joints: Nonsag joint sealant shall be used.

D. Prepare joints and install primers and joint sealants in accordance with ASTM C1193, the manufacturer's instructions, and ACI 504R.

3.02 PREPARATION

A. Verify joint dimensions and physical and environmental conditions prior to sealant application.

B. Verify that surfaces to be sealed are clean, dry, sound, and free of dust, loose mortar, oil, and other foreign materials. Correct nonconforming conditions.

1. Clean concrete surfaces by abrasive blasting

2. Hand or mechanical clean as required by the product manufacturer and as approved by the Engineer

3. Mask adjacent surfaces where necessary to maintain neat edges

4. Apply primer, where required, to dry surfaces

3.03 INSTALLATION

A. Install sealant systems to achieve the required width/depth ratios shown on the Contract Drawings. If width/depth is not indicated on the Contract Drawings, comply with the manufacturer's product data.

B. Joint filler shall be used to achieve the required joint depths.

1. Install backup material in accordance with the sealant manufacturer's printed recommendations.

2. Use full-length sections of joint-filler material. Where splices are required, minimize the number of splices. Splices shall be fitted and neat.

C. Use bond breaker as recommended by sealant manufacturer.

D. Seal expansion joints and elsewhere as shown on the Contract Drawings.

E. Tool joints slightly concave after the sealant is installed, unless otherwise recommended by the manufacturer and approved by the Engineer.

F. Finish joints free of air pockets, foreign embedded matter, ridges, and sags.

3.04 CLEANING

A. Clean surfaces adjacent to the sealed joints of masking tape, sealant, and foreign substances.

B. Damaged surfaces resulting from joint sealing or cleaning activities shall be replaced.

3.05 SCHEDULE

A. Exterior Sealant Joint (Type A) Applications:

1. Control and expansion joints in cast-in-place concrete

2. Joints between architectural and structural precast concrete units

3. Control and expansion joints in unit masonry

4. Joints between different materials listed above

5. Other exterior joints in vertical surfaces and non-traffic horizontal surfaces for which no other sealant is specified

B. Traffic Sealant Joint (Type B) Applications

1. Control, expansion and isolation joints in cast-in-place concrete

2. Control, expansion and isolation joints in structural precast concrete units
3. Joints between architectural precast concrete paving units

4. Tactile control and expansion joints

5. Joints between different materials listed above

6. Other interior and exterior traffic bearing joints in horizontal and sloped traffic surfaces

END OF SECTION

SECTION 07350

MEMBRANE WATERPROOFING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section contains requirements for sheet membrane waterproofing system for structural concrete slabs and walls as indicated on Contract Drawings.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. C836 Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course

2. D412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension

3. D570 Standard Test Method for Water Absorption of Plastics

4. D903 Standard Test Method for Peel or Stripping Strength of Adhesive Bonds

5. D1434 Standard Test Method for Determining Gas Permeability Characteristics of Plastic Film and Sheeting

6. D1876 Standard Test Method for Peel Resistance of Adhesives (T-Peel Test)

7. D1970 Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection

8. D3767 Standard Practice for Rubber - Measurements of Dimensions

9. D5385 Standard Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes

10. E96 Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials

11. E154 Standard Test Methods for Water Vapor Retarders Used in Contact with Earth under Concrete Slabs, on Walls, or as Ground Cover

1.03 SUBMITTALS

A. Submit manufacturer's product data, installation instructions and membrane samples for approval.

B. Submit shop drawings for membrane waterproofing layout and lap details for internal and external corners, penetrations, slab to pile connections, tie-ins, and terminations as applicable for approval.

C. Supply the Engineer with membrane waterproofing details that comply with the membrane waterproofing manufacturer's recommendations in the vicinity of drill and bond dowels for approval.

1.04 QUALITY ASSURANCE

A. Pre-Installation Conference: Hold a pre-installation conference prior to commencement of field operations to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work. Include in the agenda for meeting review of special details and flashing.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in labeled packages. Store and handle in strict compliance with manufacturer's instructions. Protect from damage from weather, excessive temperature and construction operations. Remove and dispose of damaged material in accordance with applicable regulations.

1.06 PROJECT CONDITIONS

A. Perform work only when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials used. Proceed with installation only when the substrate construction and preparation work is complete and in condition to receive sheet membrane waterproofing.

1.07 WARRANTY

A. Sheet Membrane Waterproofing: Provide written five year material warranty issued by the membrane manufacturer upon completion of work.

PART 2 - PRODUCTS

2.01 MATERIALS

A. For each type of material required for the work of this section, provide primary materials which are the products of one manufacturer.

B. Propose a material type satisfying the minimum standards in table below and approved by the Engineer:

Property	Test Method	Typical Value
Color		Black with white protective coating
Thickness	ASTM D 3767 Method A	1.42 mm (0.056 inch) nominal
Low Temperature Flexibility	ASTM D 1970	Unaffected at -23°C (-10°F)
Elongation	ASTM D 412 Modified[1]	300% minimum
Crack Cycling at -23°C (-10°F)	ASTM C 836	Unaffected
Tensile Strength, Film	ASTM D 412	27.6 MPa (4,000 lbs/inch^2)
Peel Adhesion to Concrete	ASTM D 903 Modified[2]	880 N/m (5.0 lbs/inch)
Lap Adhesion	ASTM D 1876 Modified[3]	440 N/m (2.5 lbs/inch)
Resistance to Hydrostatic Head	ASTM D 5385 Modified[4]	70 m (231 ft) minimum
Puncture Resistance	ASTM E 154	800 N (180 lbs) minimum
Permeance	ASTM E 96 Method B	0.6 ng/m^{2}sPa (0.01 perms)
Water Absorption	ASTM D 570	0.5% maximum

1. Elongation of membrane is run at a rate of 50 mm (2 inches) per minute.

2. Concrete is cast against the protective coating surface of the membrane and allowed to properly dry (7 days minimum). Peel adhesion of membrane to concrete is measured at a rate of 50 mm (2 inches) per minute at room temperature.

3. The test is conducted 15 minutes after the lap is formed and run at a rate of 50 mm (2 inches) per minute at -4°C (25°F).

4. Hydrostatic head tests are performed by casting concrete against the membrane with a lap. Before the concrete sets a 3 mm (0.125 inch) spacer is inserted perpendicular to the membrane to create a gap. The cured block is placed in a chamber where water is introduced to the membrane surface up to a head of 70 m (231 ft) of water.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Employ Installer to examine conditions of substrates and other conditions under which this work is to be performed and notify the contractor, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions are corrected.

3.02 SURFACE PREPARATION

A. Compact earth and stone substrates well enough to produce an even, solid substrate. Remove loose aggregate. Finish concrete substrates in accordance with Section 03170 Concrete Finishing. Fill gaps or voids greater than 0.5 inches. Remove standing water prior to membrane applications.

3.03 INSTALLATION

A. Refer to manufacturer's literature for complete installation instructions, but not limited to, the following:

1. Apply membrane with the HDPE film facing the prepared substrate. Remove the release liner during application..

2. Apply succeeding sheets by overlapping the previous sheet 3 inches along the uncoated edge of the membrane. Lap area must be firmly rolled to ensure a tight seal.

3. Overlap the ends of the membrane a minimum of 3 inches and apply tape as recommended by the manufacturer centered over the lap. End lap area must be firmly rolled to ensure a tight seal.

4. Do not puncture, scratch or rupture membrane, remove sections that have been punctured, scratched or ruptured and overlap a min of 3" and apply tape as recommended by manufacturer.

3.04 CONCRETE PLACEMENT

A. Place concrete slab within 30 days of membrane application.

END OF SECTION

SECTION 09650

DETECTABLE WARNING TACTILES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for detectable warning tactile panels for installation at the following locations: Station platform edge, and the pedestrian crossings at stations, and at vehicular grade crossings. See Section 09655 for detectable guide tactiles.

B. The tactile panels (panels) shall be surface install for installation only on concrete surface.

1.02 REFERENCE STANDARDS

A. ADA (Americans with Disability Act) Standards for Transportation Facilities, 2006 or latest

B. ASTM International (ASTM):

1. B117 Standard Practice for Operating Salt Spray (Fog) Apparatus
2. C501 Standard Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser
3. D570 Standard Test Method for Water Absorption of Plastics
4. D638 Standard Test Method for Tensile Properties of Plastics
5. D695 Standard Test Method for Compressive Properties of Rigid Plastics
6. D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
7. D1308 Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Coating Systems
8. D5420 Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact)
9. E84 Standard Test Method for Surface Burning Characteristics of Building Materials
10. G155 Standard Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials

C. Caltrain Standard Drawings

1.03 SUBMITTALS

A. Shop Drawings: showing fabrication details; panel surface profile; fastener locations; plans of panel placement including joints, and material to be used as well as outlining installation materials and procedure. Include procedures for containment and disposal of milling and saw cutting waste water.

B. Product Data: manufacturer's literature describing products and installation procedures. Include product data for adhesives and sealants.

C. Samples:

1. Samples of panels measuring at least 12 inches x 12 inches. Panel sampled shall include longitudinal edge with integral flange and transverse ship-lap edges.

2. Samples of panels and sealant for verification of color match.

D. Maintenance Instructions: Manufacturer's specified maintenance practices for each type of panel and accessory as required.

E. Quality Assurance Submittals:

1. Material Test Reports: test reports from qualified independent testing laboratory indicating that materials proposed for use are in compliance with requirements and meet the properties specified in this Section. Tests which indicate performance for the panels shall have been performed within three (3) years of the Invitation to Bid.

2. Submit list of projects in California that successfully demonstrate the proposed products' durability and weatherability.

1.04 QUALITY ASSURANCE

A. Panels and accessories, including panel adhesive, fasteners, and sealants, shall be from a single source. Products shall have been in successful service for a period of five (5) years.

B. Installer's Qualifications: Engage an experienced Installer certified in writing by panel manufacturer as qualified for installation, who has successfully completed panel installations similar in material, design, and extent to that indicated for Project. Only persons who are thoroughly trained and experience in the installation of the panels shall perform the work.

C. Provide services of manufacturer's field representative who shall be present at all times during installation.

1.05 DELIVERY, STORAGE AND HANDLING

A. Panel type shall be identified by part number on packages.

1.06 SITE CONDITIONS

A. Environmental Conditions and Protection: Perform field work only when environmental conditions fall within those recommended by manufacturers of the products.

1.07 WARRANTY

A. Panels shall be covered by a written warranty for a period of five (5) years from date of final completion. The warranty includes defective work, breakage, deformation, delamination, fading and chalking of finishes, and loosening of panels. Warranty shall include furnishing new materials, removal of existing panels, and installation of new panels.

1.08 EXTRA STOCK

A. Furnish four (4) additional panels of each type of installed panels and corresponding fasteners. Deliver extra stock to location (within 30 mile radius of work site) designated by the Engineer. Furnish extra stock materials from same manufactured lot as materials installed and enclose in protective packaging with appropriate identification.

PART 2 - PRODUCTS

2.01 PANELS

A. Manufacturers: Subject to conformance with the requirements of this Section, use products fabricated by the following manufacturers may be acceptable, or other Engineer approved equal:

1. ADA Solutions, Inc.

2. Armor-Tile by Engineered Plastics, Inc.

B. Panels shall be homogenous glass and carbon reinforced composite or an epoxy polymer composition which is color and UV stable. Color shall be Federal Safety Yellow (FS 33538) and homogenous throughout the panel thickness.

C. Truncated Dome Geometry:

1. Truncated dome surface shall comply with ADA guidelines, 705, Detectable Warnings. (Title 49 CFR Transportation, Part 37.9 Standards for Accessible Transportation Facilities, Appendix A, Section 4.29.2 – Detectable Warnings on Walking Surfaces).

2. Truncated Dome Description:

a. Staggered Dome and In-Line Patterns (nominal dimensions): The truncated dome shall measure 0.45 inch diameter at the top of the dome, 0.90 inch diameter at the base of the dome, 0.20 inch high, and 1.6 inch on center (staggered pattern) and 2.35 inch on center (in-line pattern).

b. In order to ensure a uniform appearance of the detectable warning surface throughout the system, equivalent facilitation findings or alternate patterns will not be acceptable.

3. Truncated dome pattern shall align properly from Panel to Panel.

D. Panel Configuration:

1. Panel thickness: 3/8 inches minimum, solid thickness for all type of panels.

2. Butt Joint, Staggered Truncated Domes:

a. For station platform edge (staggered pattern): Nominal 24 inches × 48 inches with a 7/16-inch thick deep flange along both long sides. The perimeter of the standard panel features a chamfer (no 90 degree return).

b. For station pedestrian crossings (staggered pattern): Nominal 36 inches × 48 inches (or longer) with a 7/16-inch thick deep flange along both long sides. The perimeter of the standard panel features a chamfer (no 90 degree return).

c. For pedestrian crossings at vehicular crossings (in-line pattern): Nominal 36 inches × 48 inches (or longer) with a 7/16-inch thick deep flange along both long sides. The perimeter of the standard panel features a chamfer (no 90 degree return).

3. The panel shall feature a butt joint detail from tactile warning panel to panel. Alternatively a ship lap detail may also be furnished.

E. Fastener Holes in the Panel:

1. Holes for fasteners shall be formed in the factory. The holes shall be located only at the centers of the truncated domes.

F. Performance characteristics: Panels shall meet the following standards:

Property	ASTM Test Method	Nominal Value
Accelerated Weathering (2,000 hours)	G155	Delta E: 5.0 max
Chemical Resistance	D1308	No Stain or Discoloration
Flexural Strength	D790	25,000psi min
Compressive Strength	D695	20,000psi min
Tensile Strength	D638	10,000psi min
Gardner Impact Test	D5420	110 in-lb min
Flame Spread	E84	FSI: 25 max SDI: 150 max
Slip Resistance	C1028	Friction Coeff: 0.80 min (wet or dry)

Wear Resistance	C501	500 min
Water Absorption (2 weeks)	D570	0.20% max
Salt Spray (120 hours)	B117	No Change

2.02. ACCESSORIES

A. Fasteners for Concrete: Color matched nylon expansion sleeves with 1/4 inch diameter by 1-1/2 inches long stainless steel drive pins or as recommended by panel manufacturer for specific job conditions and accepted by the Engineer.

B. Adhesive: Type approved by the panel manufacturer.

C. Sealant: Urethane sealant of type approved by the panel manufacturer.

D. Backer Road: Acceptable to sealant manufacturer. Where required, such as at platform expansion joints.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Apply adhesives, sealants and mechanical fasteners in accordance with the guidelines provided by their respective manufacturers.

B. Utilize manufacturer-provided template to lay out area to receive panels.

C. Form recess for panels by either milling with diamond blade head or casting recess in place (at new paving) so that installed panel will still flush relative to adjacent surface. Grind or form to the depth and width required by the approved shop drawings and manufacturer's instructions. Finish cast-in-place recess with equivalent of a light broom finish. When milled, substrate shall have a light ribbed finish.

D. Contain and remove slurry resulting from concrete milling and sawcutting. Do not wash slurry into track bed area. Slurry contaminates and stains track structure and impedes drainage.

E. For Panels with Recessed Flanges:

1. Utilize diamond bladed double headed wet saw to achieve parallel grooves to receive panels. Both sawcuts shall be made simultaneously from the same machine. Sawcut parallel to platform edge.

2. After sawcutting, vacuum and power wash surface with clean clear water, free from all dirt and debris. Visually inspect surface for obtrusions or foreign matter. If obtrusions are present, remove by grinding. Remove foreign matter by grinding or further washing, as appropriate.

F. Immediately prior to application of the setting adhesive, inspect surfaces to receive panel to ensure that they are clean, dry, free of voids, curing compounds, projections, loose material, dust, oils, grease, sealers, and other contaminants. Verify that surfaces are structurally sound and that concrete has

cured a minimum of 30 days. Obtain panel manufacturer's representative's and Engineer's approval of surface preparation before installing panels.

G. Air entrapment: Apply generous amount of adhesives to eliminate air entrapment between the panels and the concrete surfaces.

H. Set panels and install fasteners in accordance with panel manufacturer's instructions and as follows:

1. Wherever possible, install full size (uncut) panels. Do not install panel sections measuring less than 24 inches in length. Only cut panels where absolutely necessary.

2. Maintain gap between panels for expansion and contraction in accordance with manufacturer's instructions.

3. At platform expansion joints, cut panels on their short sides, finish cut edges smoothly, and lay panels with cut edges aligned with the edges of the substrate along the joints. Install fasteners on either side of the expansion joint at the time of initial installation. After a minimum of 4 hours, make a sawcut measuring 5/16 inch wide across the composite detectable warning surface panel and fill with sealant. Make sawcut in the zone between truncated domes.

    a. Where there is platform curvature, composite detectable warning surface panels shall be treated in a similar manner so that the joints remain uniform across the width of the joint between successive panels. However, in areas of platform curvature, the joint shall take on somewhat of a triangular configuration.

4. Cutting through panel domes shall be kept to a minimum. Where less than half of the truncated dome remains, grind off balance of dome; where over half of the truncated dome remains, feather dome so as not to present a tripping hazard.

I. Install sealant in accordance with manufacturer recommendations.

3.02 CLEANING AND PROTECTING

A. After area has been fully tiled and sealant system applied, clean panel surface, following manufacturer recommended maintenance and cleaning procedures.

B. Protect sealant and panels against damage during construction period. Comply with panel and sealant manufacturers' recommendations.

C. Protect panels against damage from rolling loads following installation by covering with plywood or hardwood.

D. Clean panel by method specified by the manufacturer.

END OF SECTION

SECTION 09655

DETECTABLE GUIDE TACTILES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for surface applied and recessed detectable guide or directional tactiles for use on the station platforms to provide guidance or direction to the Ticket Vending Machines (TVMs) and the passenger shelters, as well as to mark the location of the mini-high platforms.

B. The tactiles shall be surface install for installation only on concrete surface.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. B117 Standard Practice for Operating Salt Spray (Fog) Apparatus
2. C501 Standard Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser
3. D543 Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
4. D570 Standard Test Method for Water Absorption of Plastics
5. D638 Standard Test Method for Tensile Properties of Plastics
6. D695 Standard Test Method for Compressive Properties of Rigid Plastics
7. D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
8. D1037 Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
9. D5420 Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact)
10. E84 Standard Test Method for Surface Burning Characteristics of Building Materials
11. G155 Standard Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials

1.03 SUBMITTALS

A. Shop Drawings: Submit shop drawings showing fabrication details; tactile surface profile; fastener locations; plans of tactile placement including joints, and material to be used as well as outlining installation materials and procedure.

B. Product Data: Submit manufacturer's literature describing products and installation procedures. Include product data for sealants.

C. Samples: Submit samples of tactile and sealant for verification of color match.

D. Samples for Verification Purposes: Submit samples of full size tactiles of the kinds proposed for use.

E. Maintenance Instructions: Submit copies of manufacturer's specified maintenance practices for each type of tactile tile and accessory as required.

F. Quality Assurance Submittals:

1. Material Test Reports: Submit test reports from qualified independent testing laboratory indicating that materials proposed for use are in compliance with requirements and meet the properties in this Section.

2. Submit list of projects in California that successfully demonstrate the proposed products durability and weatherability.

1.04 QUALITY ASSURANCE

A. Provide tactiles and accessories as produced by a single manufacturer. Products shall have been in successful service for a period of two (2) years.

B. Installer's Qualifications: Engage an experienced installer certified in writing by tile manufacturer as qualified for installation, who has successfully completed tactile installations similar in material, design, and extent to that indicated for Project.

1.05 DELIVERY, STORAGE AND HANDLING

A. Tactile type shall be identified by part number on packages.

1.06 SITE CONDITIONS

A. Environmental Conditions and Protection: Perform field work only when environmental conditions fall within those recommended by manufacturers of each product.

1.07 WARRANTY

A. Tactiles shall be covered by a written warranty for a period of five (5) years from date of final completion. The warranty includes defective work, breakage, deformation, fading, and chalking of finishes, and loosening of tactiles. Warranty shall include furnishing of new tactiles, removal of existing tactiles, and installation of new tactiles.

1.08 EXTRA STOCK

A. Furnish 10 linear feet long additional tactiles and corresponding amount of fasteners. Deliver extra stock to location (within 30 mile radius of work site) designated by the Engineer. Furnish extra stock materials from same manufactured lot as materials installed and enclose in protective packaging with appropriate identification.

PART 2 - PRODUCTS

2.01 TILES

A. Nominal dimensions: 6 inches by 48 inches long by 0.125 inches thick and 0.325 inches thick at the top of the bars. Tactiles shall be formed with holes for anchors. Color: Federal Safety Yellow (FS 33538).

B. Manufacturer: Armor Tile directional bar tiles, as manufactured by Engineered Plastics, Inc, or Engineer approved equal.

C. Material: Epoxy polymer composition employing aluminum oxide particles in the linear bars. Color shall be homogenous throughout the tactile.

D. Performance characteristics: Tactiles shall meet the following standards.

Property	ASTM Test Method	Nominal Value
Accelerated Weathering (3000 hours)	G155	Delta E: 4.5 max
Chemical Stain Resistance	D543	No stain or discoloration
Chemical Resistance	D1308	No Stain or Discoloration
Flexural Strength	D790	25,000 psi min
Compressive Strength	D695	28,000 psi min
Tensile Strength	D638	19,000 psi min
Gardner Impact Test	D5420	550 in-lb min
Flame Spread	E84	FSI: 15 max
Slip Resistance	C1028	Friction Coeff: 0.80 min (wet or dry)
Wear Resistance	C501	500 min
Water Absorption (2 weeks)	D570	0.05% max
Salt Spray (200 hours)	B117	No Change

2.02. ACCESSORIES

A. Fasteners: Stainless steel low profile expansion anchors 3/16 inch diameter by 2 inches long.

B. Adhesive: Type approved by the tactile manufacturer.

C. Sealant: Urethane sealant of type approved by the tactile manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Apply adhesives, sealants and mechanical fasteners in strict accordance with the guidelines set by their respective manufacturers.

B. Lay out area to receive tactile and mark with a thin indelible felt pen a reference grid for the tile to be laid. Lines shall be covered by tile or sealant or removed in completed installation.

C. Set the diamond head planer to the appropriate depth to achieve the necessary recess in the area to receive the tactile.

D. After planing, vacuum and power wash surface with clean clear water, free from all dirt and debris. Visually inspect surface for obtrusions or foreign matter. If obtrusions are present, remove by grinding. Remove foreign matter by grinding or further washing, as appropriate.

E. Immediately prior to application of the setting adhesive, inspect surfaces to receive tactile to ensure that they are clean, dry, free of voids, curing compounds, projections, loose material, dust, oils, grease, sealers, and other contaminants. Verify that surfaces are structurally sound and that concrete has cured a minimum of 30 days.

F. Clean backs of tactiles in accordance with manufacturer's instructions.

G. Apply the adhesive to provide a sound resonating affect after the tactile is installed. All perimeter edges of the tactile shall receive a minimum of a 1 inch perimeter bond of adhesive.

H. Inspect the tactile and clean with acetone all dust and other contaminants from the surfaces to be adhered, then set the tile in place, true and square. Drill holes true and straight to the depth required using the recommended bit with holes located by the molded recesses provided in the tactile. Clean dust from the holes with acetone to provide clear passage for the anchor and eventually the concealed cap.

I. Mechanically fasten tactiles to surface using equipment and technique per manufacturer's instructions. Ensure the fastener has been set to full depth, straight and true, leaving sufficient clearance between the top of fastener and top of dome to not interfere with the concealed cap. Prevent damage to tile surface from inadvertent blows with the hammer.

J. Maintain gap between tactiles for expansion and contraction in accordance with manufacturer's instructions.

K. Following the installation of the tactiles, apply sealant to the joint between abutting tactiles and between tactiles and adjacent surface in accordance with sealant manufacturer instructions, including masking and tooling. Clean joint and remove any debris. Cut away any excess adhesive. At sawcut, cut away any excess adhesive to provide sufficient depth for the sealant in the saw cut as indicated on the Contract Drawings.

3.02 CLEANING AND PROTECTING

A. After the area has been fully tiled and sealant system applied, clean tactile surface, following the manufacturer recommended maintenance and cleaning procedures.

B. Protect panels against damage during construction period to comply with tile manufacturer's specification.

C. Protect tactiles against damage from rolling loads following installation by covering with plywood or hardwood.

D. Clean tactiles not more than 4 days prior to date schedule for inspection intended to establish completion for each area. Clean tactile by method specified by the manufacturer.

END OF SECTION

SECTION 09900
PAINTS AND COATINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for paints and coatings.

B. Work to be performed includes:

1. Painting and finishing of exterior and interior exposed surfaces throughout the Contract, except as otherwise indicated. Surface preparation, coating application, and paint materials specified are in addition to shop priming and surface treatment specified under other Specification Sections including Structural Steel and Metal Fabrications.

2. Field painting of bare and covered pipes (including color coding in accordance with ASME A13.1 "Scheme for the Identification of Piping Systems"), and of hangers, exposed steel and iron work, and primed metal surfaces of equipment except as otherwise indicated.

3. Re-painting of existing painted surfaces as indicated on the Contract Drawings.

4. Paint exposed surfaces whether or not colors are designated in any schedule unless specifically indicated otherwise. Where surfaces are not specifically identified, paint such surfaces the same as adjacent similar surfaces.

1.02 DEFINITIONS

A. Paint: As used herein, means coating systems materials including primers, emulsions, epoxies, enamels, sealers, fillers, and other applied materials whether used as primer, intermediate, or finish coats.

1.03 EXCLUDED WORK

A. Do not paint metal surfaces of anodized aluminum, stainless steel, and similar finished materials, unless otherwise noted on the Contract Documents.

B. Do not paint over required labels or equipment identification, performance rating, name, or nomenclature plates.

C. Do not paint glass, concrete with sealer, nor other finished surfaces, unless otherwise noted or on the Contract Documents.

D. Pre-Finished Items: Field finish does not include painting when factory-finishing is specified for items such as acoustical materials, finished mechanical and electrical equipment, including light fixtures and distribution cabinets. Field touch-up is required, however, in all cases where the factory finish is damaged.

E. Miscellaneous Surfaces: Rubber and elastomeric sealants, cementitious fireproofing, and machined surfaces of metal hardware and related fittings will not require finish painting.

1.04 SUBMITTALS

A. Product Data: A complete list of materials proposed for use, together with manufacturer product specifications.

B. Samples:

1. Five 8.5 inches by 11 inches samples of each color and each gloss for each material on which the finish is specified to be applied for review and approval of the Engineer.

2. Revise and resubmit each sample until the required gloss, color, and texture is achieved. Samples approved by the Engineer will become standards of color and finish for accepting or rejecting the work of this Section.

3. Final approval of gloss, color, and texture shall be made through approval of mockups, if required by the Engineer.

4. For concrete paint samples, Contractor shall provide approximately 24 square feet mockup of each color on the structure in a location as directed by the Engineer. Engineer shall approve of each mockup, prior to proceeding with application of concrete paint.

C. Paint Systems:

1. Proposed paint systems including material and dry film thickness for each coat, quality control plan, and methods for surface preparation and paint application.

2. Paint Manufacturer’s Review: Review the proposed paint systems and application procedures with qualified representatives of the proposed paint product manufacturers. Obtain manufacturers’ written concurrence of the proposed paint systems, and Engineer’s approval of any recommended changes thereto, before providing product data, samples, and mock-ups specified herein.

1.05 DELIVERABLES

A. Certificates of Compliance: Certificates of compliance from manufacturer certifying that proposed materials comply with the specified requirements and are the manufacturer's best-quality grade materials.

B. Certificates of Compliance: Certificates of compliance from the Contractor that the manufacturer designated thickness of paint on metal has been attained and verified with a magnetic dry mil thickness gauge.

1.06 QUALITY ASSURANCE

A. Regulations: In case of conflict between regulatory requirements and specified materials, submit alternative materials to the Engineer for approval.

B. Manufacturer's Standards: Comply with manufacturer's recommendations and standards

C. Paint Coordination:

1. Provide finish coats that are compatible with the prime coat

2. Review the Contract Documents to verify the coating systems are compatible with the substrata.

D. Mockups:

1. Do not apply final coats until the colors and textures have been approved by the Engineer. To accomplish this, if requested by the Engineer, paint a sample panel of approximately 24 square feet of the colors and textures selected on every type of surface to be painted. Notify the Engineer at least three days in advance of when sample panels will be ready for review and approval.

2. For interior finishes, permanent lighting shall be installed and in operation in the rooms or areas where the sample panels have been painted. Temporary lights at the same level and of the same type, intensity, and color as the permanent lights will be permitted for viewing of sample panels.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to job in original packages and containers bearing name of manufacturer; containers shall be new and unopened and shall clearly show manufacturer's best-grade certification on each container; store appropriately and provide fire protection.

B. When materials are not in use, store in hermetically covered containers.

C. Maintain containers used in storage, mixing and application of paint in a clean condition, free from deleterious materials and residue.

1.08 SITE CONDITIONS

A. Environmental conditions specified herein are minimum parameters. Comply with manufacturer’s requirements.

B. Do not apply solvent-thinned paints when the temperature of surfaces to be painted and the surrounding air temperatures are below 45 degrees F unless otherwise permitted by the manufacturer's published instructions.

C. Weather Conditions:

1. Do not apply paint when the relative humidity exceeds 85 percent; or to damp or wet surfaces, unless otherwise permitted by the manufacturer's published instructions or this Section.

2. Do not apply paint when dust is blowing.

PART 2 - PRODUCTS

2.01 PAINT MATERIALS AND COLORS

A. Quality: Best quality grade of specified types as regularly manufactured by recognized paint and varnish manufacturers; materials not bearing manufacturer's identification as standard best grade product of regular line are not acceptable.

B. Undercoats and Thinners:

1. Provide undercoat paint produced by the same manufacturer as the finish coat.

2. Use only the thinners recommended by the paint manufacturer and use only to the recommended limits.

3. Undercoat, finish coat, thinner material, and related elements shall be components of a unified paint finish system.

2.02 MATERIAL LIST

A. Galvanized Metal Repair Material: Galvanized surfaces which have become damaged from welding, handling, or installation shall be repaired immediately after installation with galvanizing repair material in accordance with ASTM A780/A780M.

B. Zinc-Rich Primer: Factory-formulated zinc rich primer for exterior application conforming to SSPC-Paint 20 as specified in Section 05100, Metal Fabrications. The dry film thickness shall meet the recommended value in manufacturer’s product data.

C. Exterior Semi-Gloss Latex: A pigmented, water based, emulsion type, semi-gloss latex paint for exterior concrete and masonry. Product use shall comply with the Master Painters Institute (MPI) detailed performance standards and must be listed MPI’s approved products lists. The dry film thickness shall meet the recommended value in manufacturer’s product data.

D. Zinc Rich Primer for Structural Steel: Factory-formulated inorganic zinc rich metal primer for exterior application conforming to ASSHTO M300 as specified in Section 05200, Structural Steel. The dry film thickness shall meet the recommended value in manufacturer’s product data.

E. Exterior Gloss Urethane: Factory-formulated gloss urethane for exterior application meeting SSPC-Paint 36 or SPCC-Paint 38 requirements. The dry film thickness shall meet the recommended value in manufacturer's product data.

F. Miscellaneous:

1. Caulking Compound: Acrylic latex type.

G. Provide other materials not specified but required for a complete and proper application, as selected by the Contractor for approval by the Engineer.

H. Concrete Primer: A water based, alkali resistant pigmented primer used on alkaline surfaces such as plaster, vertical concrete and masonry surfaces. Product use shall comply with the MPI detailed performance standards and must be listed MPI's approved products lists. The dry film thickness shall meet the recommended value in manufacturer's product data.

2.03 APPLICATION EQUIPMENT

A. Spray and Roller Equipment: Proper type for work, subject to the approval of the Engineer.

PART 3 – EXECUTION

3.01 SURFACE CONDITIONS

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.02 MATERIALS PREPARATION

A. General:

1. Mix and prepare paint materials in accordance with the manufacturer's published instructions.

B. Stirring:

1. Stir materials before application producing a mixture of uniform density.

2. Do not stir film, which may form on the surface into the material. Remove the film and strain or filter the material appropriately before using.

3.03 SURFACE PREPARATION

A. General:

1. Cure concrete for a minimum of three (3) weeks prior to applying paint.

2. Moisten concrete surface prior to applying paint to prevent concrete from absorbing water out of paint.

3. Concrete: Remove efflorescence, chalk, form release agent, and other materials from surface of concrete which will inhibit adherence and coverage of paint. Brush concrete or apply primer coat of low viscosity penetrant paint to prepare walls and ceiling to receive top coats.

4. Protect all adjacent finish surfaces from paint including colored concrete pavement, rolling grille, signage, light fixtures, switches and switch boxes, and other finished surfaces.

5. Perform preparation and cleaning procedures in accordance with the paint manufacturer's published instructions and as approved by the Engineer. Clean concrete and metal surfaces free of all mill rust, form release agents, and efflorescence and prime metals.

6. Remove removable items, which are in place and are not scheduled to receive paint finish; or provide surface-applied protection prior to surface preparation and painting operations.

7. Following completion of painting in each space or area, reinstall the removed items by using workers who are skilled in the appropriate trades.

8. Clean each surface to be painted prior to applying paint of surface treatment.

9. Remove oil and grease with clean cloths and cleaning solvent of low toxicity and flash point in excess of 200 degrees F prior to start of mechanical cleaning.

10. Schedule the cleaning and painting so that dust and other contaminants from the cleaning process will not fall onto or affect wet newly painted surfaces.

B. Preparation of Metal Surfaces:

1. Thoroughly clean surfaces until free from dirt, oil, grease and the like.

2. On galvanized surfaces, prepare metal surface for painting in accordance with ASTM D7396.

3. Allow to appropriately dry before application of paint.

3.04 PAINT APPLICATION

A. General:

1. The dry film thickness be at least that recommended in manufacturer’s product data. The manufacturer’s specified number of coats is the minimum acceptable. If full coverage or required dry film thickness is not attainable with the manufacturer’s specified number of coats, apply additional coats as necessary to achieve coverage and required thickness.

2. Apply material evenly without runs, sags, crawls, holidays, or other defects. For brush work, brush out smooth and leave a minimum of brush marks. Where paint is rolled on, use fine nap roller so that a nearly flat or orange peel texture is obtained.

3. Touch-up shop-applied prime coats, which have been damaged and touch-up bare areas prior to start of finish coats application.

4. Do not apply additional coats until the previous coat has been inspected and approved by the Engineer.

5. Only the inspected and approved coats of paint will be considered in determining the number of coats applied.

6. Sand and clean dust and other debris between coats to remove defects visible to the unaided eye from a distance of 5 feet.

7. On removable panels and hinged panels, paint the back sides to match the exposed sides.

B. Drying and Re-Coat Window:

1. Allow sufficient drying time between coats, modifying the period as recommended by the material manufacturer to suit weather conditions.

2. Comply with manufacturer's re-coat timing restrictions.

C. Spray Application:

1. Confine spray application to metal framework and similar surfaces where hand brushwork would be inferior.

2. Where spray application is used, apply each coat to provide the hiding equivalent of brush coats.

3. Do not double back with spray equipment to build up film thickness of two coats in one pass.

4. Concrete surfaces to be painted shall be prepared in conformance with the requirements of SSPC-SP 13/NACE No. 6 "Surface Preparation of Concrete," of the "SSPC: The Society of Protective Coatings." The coating shall be applied per the manufacturer's recommendations and in conformance with the requirements of SSPC-PA 7, "Applying Thin Film Coatings to Concrete" of the SSPC: The Society of Protective Coatings." The final appearance shall have an even and uniform color acceptable to the Engineer.

5. For concrete surfaces such as columns, retaining walls and abutments, primer shall extend to 1 foot below the finish ground line, unless otherwise shown in the Plans.

D. Completed work shall match the samples approved by the Engineer as to texture, color, and coverage.

3.05 FIELD QUALITY CONTROL

A. Testing: Measure thickness of paint on metal with magnetic dry mil thickness gauge to verify that manufacturer designated thickness has been attained and supply the Engineer with a certificate of compliance that said thickness has been attained.

3.06 PROTECTION AND CLEANUP

A. Protection: Protect building elements and components, paving, landscaping, and vehicles from damage, staining, overspray, marking, soiling, and the like. Leave work clean, whole, and as new. Correct damage by cleaning, repairing, replacing, or repainting.

B. Hardware, Fixture Canopies, Outlet Covers, Switch Plates and Similar Items: Remove or loosen and replace as required for painting work. New hardware except for hinges shall not be installed until painting and finishing work is completed; mask and protect hinges from paint or damage.

C. Cleanup: During progress of work clean up discarded paint materials debris cans, rags and the like; remove from the project site. Implement applicable safety methods in control or disposal of flammable materials.

3.07 PAINTING SCHEDULE

A. Finish System for Ferrous and Galvanized Metal:

1. Prime Coat: Apply Zinc Rich Primer to metal surfaces not primed in shop. For shop primed and galvanized metal, additional prime coat is not required. Apply touch-up primer to repair damaged areas with approval from the Engineer.

2. Intermediate and Finish Coats: Exterior Semi-Gloss Latex.

B. Heavy Duty Finish System for Structural Steel:

1. Prime Coat: Shop prime with Zinc Rich Primer for Structural Steel as specified in Section 05200, Structural Steel. Apply touch-up primer to repair damaged areas with approval from the Engineer.

2. Intermediate and Finish Coats: Exterior Gloss Urethane.

C. Finish System for Concrete and Masonry:

1. Prime Coat: Concrete Primer.

2. Intermediate and Finish Coats: Exterior Semi-Gloss Latex.

END OF SECTION

SECTION 10100
STATION FURNISHINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for station site furnishings.

1.02 SUBMITTALS

A. Submit manufacturer's product data and installation instructions.

B. Color Samples:

1. Powder Coating: Submit manufacturer's color palette to the Engineer for selection.

2. Submit manufacturer's color palette for trash receptacle lids.

PART 2 – PRODUCTS

2.01 SITE FURNISHINGS

A. Benches: Exterior application, Model No. PP423D, Prestige Contour Series, Gullwing – diamond pattern, as manufactured by Wabash Valley Manufacturing, or Engineer approved equal.

1. 8 feet length with side and center arms.

2. Finish: Heavy-duty galvanized steel frame with scratch-resistant finish and "plastisol" coating.

3. Color: a) Federal ADA blue (for ADA applications), and b) Federal Brown (PMS color 4625) for others.

4. Precast concrete benches of equivalent durability are acceptable for the Engineer's consideration as equal.

B. Bike Lockers: Model No. DL100-2-F-P, piano hinged stainless steel Dura-Locker, or Engineer approved equal. See Caltrain Standard Drawing.

1. With floors

2. Hinges and Fasteners: Door hinge shall be 16 gage piano-type running full height of door frame. Fasteners shall be fastened from the inside only.

3. Lock Style: Stainless steel heavy duty 4266 Pop-out Chicago 'T' handle with two user keys (keyed differently).

C. Bike Racks (city approved): Surface mount stainless steel "U" round bike rack, by DERO, or Engineer approved equal.

1. Size: 24" wide, schedule 40 pipe

D. Bird Barrier System: Stealthnet, of Bird Barrier America, Inc., or Engineer approved equal. Translucent, 3/4 inch mesh. Include attachments, perimeter cables, tensioners, clamps, netting and net rings and access hatches for light fixtures as required for complete installation.

E. Bollards: Galvanized standard weight steel pipe of the size shown on the Contract Drawings for use as traffic bollards.

1. Steel Pipe: ASTM A 53, Type E or S, Grade B

2. Nominal diameters: 4 inches (standard applications), and 6 inches (heavy duty applications)

3. Anchors: Epoxy anchors of the size shown on the Contract Drawings

F. Clipper System:

1. Card Interface Device (CID) units and mounting pedestals are furnished by others.

G. Convex Mirror: Model No. RP-1426MR, Klear-VU, 24"x 36" roundtangular mirror, acrylic convex with steel back and swivel mount with mounting brackets, as manufactured by Reflection Products, Inc., McHenry, IL, and Roswell, GA, or equal.

H. Trash Receptacle: SKU No. TR24C, as manufactured by Dominion Precast (dominionprecast.com), or Engineer approved equal.

1. Manufacturer: Dominion Precast a division of 794754 AB LTD.
PO Box 143, Shaughnessy Alberta
TOK 2A0 Canada
Email: info@dominionprecast.conm

2. Model: SKU No. TR24C

3. Description: Super heavy duty square trash receptacle with polished concrete top, exposed aggregate body, powder coated metal side service door and plastic bin liner.

4. Dimensions: 24 in. by 24 in. by 36 in. high

5. Weight: 900 lbs.

6. Side service door

a. Lockable

b. Color: Grey

I. Furnish vandal resistant anchor bolts to suit anchorage in substrate indicated on the Contract Drawings.

J. Furnish anchors, bolts, sleeves, and templates required for complete installation to ensure proper fit and accurate placement.

2.02 FABRICATION

A. Fabricate and finish site furnishings in shop.

B. Provide miscellaneous metal items required for completion of the work.

C. Provide concealed connections where possible. Exposed connections shall be vandal-proof connectors.

PART 3 – EXECUTION

3.01 GENERAL

A. Prior to commencement of work, carefully inspect the installed work of other trades. Verify that all such work is correct and complete. Correct any discrepancy before proceeding with the work.

3.02 INSTALLATION

A. Install site furnishings in accordance with manufacturer installation instructions and as indicated on the Contract Drawings. Install site furnishings plumb, level, square, in true alignment and firmly anchored without rocking. Construct footing leveling pads as needed for level installation.

B. Install bike lockers to allow for the door opening.

C. Bollards:

1. Anchor posts or pipe sleeve in concrete as shown. For permanent fixed bollards, fill solidly with concrete with minimum compressive strength of 2500 psi.

2. Bollard: Field painted as specified in Section 09900, Paints and Coatings.

D. Clipper System:

1. Install all owner furnished pedestals, and associated conduits and cables. CID units are to be installed by others.

END OF SECTION

SECTION 10200
STATION SHELTERS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for prefabricated station shelters for the following applications: Persons Needing Assistance (PNA) Shelters, Passenger Shelters, and Ticket Vending Machine (TVM) Shelters.

1.02 SUBMITTALS

A. Shop Drawings: Submit shop drawings of stations, including installation details, for Engineer's approval.

B. Product Data: Submit manufacturers' product data and maintenance instructions.

C. Samples: Submit the following samples for Engineer's approval:

1. Glass: ¼ inch thick safety tempered glass, clear

2. Powder Coat and Bench Colors: Manufacturer's color palette for Engineer's approval

PART 2 – PRODUCTS

2.01 PRODUCTS

A. Shelters: Shelters shall be Slimline Gable series products of Brasco International, Inc. or Engineer approved equal. See Caltrain Standard Drawing for sizes and dimensions.

B. Structural framing shall be dark bronze powder coated finish. Aluminum standing seam gable roof with smooth gable ends.

C. Shelter fasteners including anchors to substrate shall be vandal-proof.

D. Shelters shall contain:

1. Engineered plastic (HDPE) bench with backrest. Finish – simulated wood appearance

2. Two 20 Watt LED lamps

PART 3 - EXECUTION

3.01 INSTALLATION

A. Securely attach shelters to substrate, level and plumb.

B. Repair damaged finishes in accordance with manufacturer's instructions.

C. Firmly attach Owner-furnish decal labels on shelters.

END OF SECTION

SECTION 10500

WHEEL CHAIR LIFT AND SHED

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for ADA compliant mobile wheel chair lifts and accompanying bridge plate for accessing train cars.

B. Include with each lift a metal steel enclosure or shed for outdoor environment. See Caltrain Standard Drawings for details of the lift and shed.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer product data including operation and maintenance instructions.

B. Provide sample of the gravity latch for the shed for approval by the Engineer.

1.03 DELIVERY

A. Operation and Maintenance Manual (O&M Manual) of the wheel chair lift.

PART 2 - PRODUCTS

2.01 PRODUCTS

A. Wheelchair Lift: Model Mobilift/TX, as manufactured by Adaptive Engineering Inc., or Engineer approved equal.

B. Features: Lift capacity: 600 lbs. Manually operated and portable without electrical or hydraulic components. Automatically self-leveling so it can be used on uneven ground. Lift height: 5 ft maximum. Width: 37.5 inches. Designed for exterior use. Vandal resistant.

C. Bridge plate: 36 inches long.

D. Wheelchair Shed: Hot dip galvanized steel construction for exterior use with vandal proof secure system.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Secure the shed at the location as shown on the Contract Drawings. Store the wheel chair lift inside the shed.

END OF SECTION

SECTION 10900
RIGHT-OF-WAY SIGNAGE

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for exterior signage including object markers, such as mile post markers, tenth mile post markers, station one mile signs, station, roadway and parking lot signage.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. A240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

2. B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

3. D635 Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position

4. D3841 Standard Specification for Glass-Fiber-Reinforced Polyester Plastic Panels

5. D4956 Standard Specification for Retroreflective Sheeting for Traffic Control

B. California Manual on Uniform Traffic Control Devices (CA MUTCD)

C. State of California, Department of Transportation (Caltrans), Standard Specifications:

1. Section 56 Overhead Sign Structures, Standards, and Poles

2. Section 75 Miscellaneous Metal

3. Section 82 Signs and Markers

D. State of California, Department of Transportation (Caltrans), Standard Plans.

1.03 SYSTEM DESCRIPTION

A. Signage, unless otherwise noted, shall conform to Caltrans Standard Specifications, Section 56, Signs, and CA MUTCD. Sign panels shall be furnished by the Contractor.

B. Owner will provide a "camera-ready" copy of the colored Caltrain™ logo.

1.04 SUBMITTALS

A. Shop Drawings: Show sizes and thickness of all members, types of materials, methods of construction and assembly, complete sign and framing dimensions including span length and post heights, hangers, brackets, anchorage, relationship to surrounding work by other trades, shop finishes, sign designs, layouts, lettering (including letter spacing), and other pertinent details of fabrication and installation.

B. Manufacturer's Data: Sign manufacturer's descriptive data.

C. Samples: Samples of all materials under this Section, as follows:

1. Of all colors proposed for use on all signs, at least 8 inches by 8 inches.

2. Full-size paper proofs of all signs, marked with proposed colors.

3. After approval of color match and lettering proofs, submit for approval one full size sign of each type, as selected by the Engineer, complete and ready for installation. Submit as many times as necessary until approval by the Engineer has been obtained. Sample sign, upon approval, shall serve as the standard to be equaled by all other work.

4. Manufacturer's color palette for sign panels and frames for color selection.

D. Existing sign inventory: Submit a field verified inventory of all existing signs to be replaced within the limits of work prior to the removal of any signs. Include latitude and longitude of the signs.

1.05 QUALITY ASSURANCE

A. Installation work under this Section shall be performed by experienced sign installers.

B. Layout of Work: Prior to the installation of signs, the Contractor shall mark the location of the signs, and request inspection and approval of the layout before proceeding with the application of the work.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Ship sign panels in such a manner as to ensure their arrival on the job site in an undamaged condition.

B. Deliver and store material in a manner to prevent cracking, chipping or stress of the components, and to prevent mechanical damage or weather damage.

1.07 WARRANTY

A. Provide a 5 year warranty against material defects.

PART 2 – PRODUCTS

2.01 NON-ILLUMINATED SIGN PANELS

A. Aluminum Sign Panels:

1. Flat sheet aluminum sheeting conforming to ASTM B209, Alloy 6061-T6, 0.08 inch thick minimum. The aluminum sheeting must be pretreated for corrosion resistance as specified in ASTM B449. The surface of the sheeting must be cleaned, deoxidized, and coated with a light, tightly-adherent chromate conversion coating free from powdery residue. The conversion coating must be Class 2 with a weight from 10 to 35 mg/sq ft and an average weight of 25 mg/sq ft. After the cleaning and coating process, the aluminum sheeting must be protected from exposure to grease, oils, dust, and contaminants. The aluminum sheeting must be free from buckles, warps, dents, cockles, burrs, and other defects resulting from fabrication.

2. The retroreflective sheeting shall comply with ASTM D 4956 Class III or higher. The sheeting shall be applied as specified by the sheeting manufacturer to recommended, properly prepared flat surfaces without the necessity of additional adhesive coats on the reflective sheeting or application surface.

3. Application of all lettering, arrows, and other artwork shall be by photographic silk screen.

B. Fiberglass Reinforced Plastic Sign Panels:

1. Products: Fiberglass-reinforced plastic panel must comply with ASTM D3841. One of the following products are in compliance with the requirements specified herein: Fiber-Brite; Sequentia, "Polyplate," Inteplast Group "InteCel" (0.5 inch for Post-Mounted CZ Signs, 48 inches or less), or Engineer approved equal.

2. The sign panel shall be retroreflective prismatic in accordance with ASTM D 4956 Class III or higher. The sheeting shall be applied as specified by the sheeting manufacturer to recommended, properly prepared flat surfaces without the necessity of additional adhesive coats on the reflective sheeting or application surface.

3. The plastic must be acrylic modified and UV stabilized for outdoor weatherability, contain additives designed to suppress fire ignition and flame propagation (when tested under ASTM D635, the extent of burning must not exceed 1 inch), and be stabilized to prevent the release solvents and monomers. The front and back surfaces of the laminate shall be clean and free of constituents and releasing agents that can interfere with the bonding of retroreflective sheeting.

4. Panel shall be weather resistant Grade II thermoset polyester laminate.

5. Color of fiberglass reinforced plastic panels shall be uniform gray.

6. Panels shall be minimum 0.135-inch thick.

7. Tolerances: Finished fiberglass reinforced plastic panel signs shall be flat within a tolerance of ±1/32 inch per linear foot when measured across the plane of the sign in all directions. The finished signs specified dimensions shall have a tolerance within ±1/8 inch.

8. Fabrication: Cut fiberglass reinforced plastic panels from a single piece of laminate. Pre-drill bolt holes. Fabricate true and smooth predrilled bolt holes, panel edges, and the front and back surfaces of the panels. The panel surfaces shall be free of visible cracks, pinholes, foreign inclusions, warping and wrinkles that can affect performance and serviceability.

2.02 TYPEFACE (TEXT)

A. Font shall be Helvetica medium with industry standard normal letter spacing.

B. Bring any design conflict in the manufacture and fabrication of the signage to the attention of the Engineer before proceeding.

2.03 SIGN FRAMES

A. Fabricate required steel framing, sign back bracing and support posts in accordance with Caltrans Standard Specifications, Section 75, Miscellaneous Metal.

B. Hot-dip galvanize steel framing, mounting components, hardware and appurtenances after fabrication and touch up as specified in Section 05500, Metal Fabrications, and with Caltrans Standard Specifications, Section 75, Miscellaneous Metal.

C. Frames for fiberglass sign panels: Extruded aluminum tubing conforming to the manufacturer's requirements for each sign type. Finish shall be satin anodized in color selected by the Engineer.

2.04 FASTENINGS AND ANCHORS

A. Unless otherwise noted, design a complete system of fastenings and anchorage devices for the various signs, as required for attachment to the various supporting structures.

B. Straps and Saddle Brackets: Stainless steel conforming to the requirements of ASTM A240, Type 302 or 304, for mounting sign panels on electroliers, sign structure posts, and where shown on the Contract Drawings.

C. Theft and vandal proof bolts: Stainless steel with a chromium content of at least 16 percent and a nickel content of at least 8 percent.

D. Lag Screws, Bolts (Except Theft-Proof Bolts), Metal Washers and Nuts: Commercial quality steel, hot dip galvanized after fabrication in accordance with Caltrans Standard Specifications, Section 75, Miscellaneous Metal. Fiber washers shall be of commercial quality.

E. Fastenings and anchors for fiberglass sign panels shall conform to the sign panel manufacturer's requirements for each sign type.

2.05 SIGN COLORS

A. Standard paint colors as manufactured by Dupont, or Engineer approved equal, and as follows:

Color	Imron (spray)	Dulux(brush)
Red	68209UM	93-58209H
Yellow	6808U	93-6808
White	617U	93-21667
Black	69	93-005

B. For fiberglass sign panels, as selected from manufacturer's color palette.

2.06 POSTS

A. Metal Posts (Aluminum Signs only): Metal posts shall be in accordance with Caltrans Standard Specifications, Section 82-3.02, Metal Posts.

B. Wood Posts: Wood posts shall be in accordance with Caltrans Standard Specifications, Section 82-3.02C, Wood Posts, with the following additional requirements:

1. Posts shall be 4 x 4 inches nominal size unless otherwise indicated on the Contract Drawings.

2. Preservative treat posts other than all heart redwood. Kiln dry prior to treatment

C. Aluminum Posts for Fiberglass Sign Panels: Extruded aluminum tubing conforming to the manufacturer's requirements for each sign type. Finish shall be satin anodized.

D. Object Marker: Type P, conforming to the details shown on Caltrans Standard Plan A73B.

PART 3 – EXECUTION

3.01 SIGN INSTALLATION

A. Install signs true, plumb, and level, where shown on the Contract Drawings. Do no field cutting of any sign work. Prevent bending and chipping signs. Exercise extreme care in all handling and stacking of signs to avoid bending or chipping. Replace chipped and bent sign panels. Exact locations of signs will be confirmed by the Engineer in the field.

B. Rigidly anchor work to the supporting construction, as shown on the approved shop drawings. Conceal fastenings, except those which anchor supporting members to structure. Fabricate and erect supporting members and securely

attach to the various structures in accordance with Caltrans Standard Specifications, Section 75, Miscellaneous Metal.

C. Subsequent to erection, if required by the Engineer, exterior signs may be required to be covered until their actual use is required. Material used to temporarily cover any sign panel shall effectively conceal the message and be non-injurious to the panel, its finish, and its structural integrity.

D. Locations of exterior railroad signage such as mile post markers, tenth mile post markers, and station one mile signs shall be installed as indicated on the Standard Drawings SD9103, SD9107, or as approved by the Engineer.

E. Locations of station, roadway and parking lot signs are as shown on the Contract Drawings.

3.02 POST INSTALLATION

A. Install posts in accordance with Caltrans Standard Specifications, Section 82, Signs and Markers, with the following additional requirements:

1. The remaining space around the post in the post holes shall be backfilled with concrete.

2. Dispose of surplus excavated material as specified in Section 02300, Earthwork.

3. Repair any spalling, chipping or cracking of concrete structures. Obtain the Engineer's approval of repair method.

4. Unless otherwise noted, do not paint wood posts and blocks.

5. Touch-up galvanized metal as specified in Section 05100, Metal Fabrications, or as specified in Caltrans Standard Specifications Section 75-1.02B, Galvanizing.

3.03 REMOVING, RELOCATING, REINSTALLING AND SALVAGING EXISTING SIGNS

A. Remove, relocate, and salvage existing signs in accordance with Section 02220, Demolition, as augmented herein.

B. Remove and re-install existing signs in new locations as shown on the Contract Drawings. Provide all necessary components required for erecting the existing sign in its new location, including support framing, hardware, post, post holes and concrete. Obtain Engineer's inspection for defects and approval of signs to be relocated prior to re-installation.

C. Where existing Milepost signs at one-tenth mile intervals need to be removed to facilitate the Contractor's construction operations, remove and reinstall, or remove and replace with new signs. Relocate Milepost signs to a new location if the existing location changes due to new track alignment.

D. Salvaging of signs shall include removing, disassembling, preparing, marking, bundling, packaging, tagging, hauling and stockpiling. Signs to be salvaged shall

not be removed until their use is no longer required as determined by the Engineer. Salvaged materials shall be cleaned of all foreign materials and pressed flat before delivery to the Engineer.

E. Existing posts, which support signs that are to be salvaged, shall become the property of the Contractor and shall be disposed of outside the work site. Refer to General Conditions 7.15, Disposal of Material Outside of the Work Site.

F. Protection and cleanup requirements for the new signs shall apply to the existing signs once that have been reinstalled.

3.04 PROTECTION AND CLEANING

A. Protect and maintain completed sign panels in good condition, free from dirt, scratches, hand marks or other blemishes.

B. Clean surfaces of sign work as recommended by the sign manufacturer after installation and keep in a condition satisfactory to the Engineer.

C. Remove and replace defective work, including that exhibiting cracked, chipped, scratched, abraded, or otherwise damaged finishes, with work conforming to the specified requirements.

3.05 DISSIMILAR MATERIALS

A. Separate aluminum surfaces in contact with or in close proximity to non-compatible metals or concrete with non-absorptive tape, coat of heavy-bodied bituminous paint, or zinc chromate primer.

END OF SECTION

SECTION 15000

BASIC MECHANICAL REQUIREMENTS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes basic mechanical requirements to complete the work as shown on the Contract Drawings and as specified herein. Provide all work and miscellaneous items, not specifically mentioned by reasonably inferred for complete operable systems.

1.02 DESIGN REQUIREMENTS

A. Design anchorage and secure mechanical equipment in accordance with applicable code. In addition, design anchorage and secure equipment to withstand a lateral force of 0.6 times the weight of the equipment, if such requirement is more stringent.

1.03 SUBMITTALS

A. General: The following are in addition to the submittal requirements in the individual Division 15 Sections.

1. Material list

2. Manufacturer's data: Certified by the factory's corporate officer

3. Shop drawings: As required under the general requirements specified in this Section and as required under individual Division 15 Sections.

4. Calculations: Structural calculations showing that equipment anchorage will withstand applicable lateral forces. Submit other calculations as specified in individual Sections. Calculations shall be stamped and signed by a Professional Civil or Structural Engineer currently licensed in the State of California.

B. Material List:

1. Submit a complete list of material and equipment proposed for the job, including manufacturer's name.

2. Reference all listing items to applicable specification sections and articles.

3. List only name of manufacturer and parts. Performance data are not required before the material list is reviewed.

4. Submit complete list of materials and equipment, even if same as specified or shown on the Contract Drawings.

C. Manufacturer's Data:

1. Submit after review of material list. Include data for all material and equipment that will be installed.

2. Include complete catalog information such as construction, capacity, types, pump curves, sizes, finish, mounting methods and operating noise levels. Provide factory certified submittals.

3. Reference all listing items to applicable specification sections and articles, and submit in brochure form.

4. For any material specified as ASTM, Federal Specifications, or industry standards, furnish the manufacturer's certification that the material furnished for the work does in fact equal or exceed such requirements.

D. Submittals shall be factory or manufacturer certified.

E. Shop Drawings: Submit the following at 3/8 inch scale or larger, in order to show all pertinent features of the equipment and method of installation and connection to the work. These requirements are in addition to those specified in Section 01300, Submittals and Deliverables.

1. Equipment layout drawings to scale, including equipment, ductwork, piping, including plumbing, accessories, showing clearance for operating and servicing. Indicate bottom elevations for all equipment. Indicate all existing equipment and ductwork, piping, and point of connection of new work.

2. Piping diagrams of all major systems, showing all equipment, accessories, and sizes.

3. Wiring diagrams shall include all low and line voltage wiring and equipment.

F. Submit Operations and Maintenance Manuals (O&M Manuals) as specified in Section 01700, Contract Closeout, for all mechanical equipment and systems.

1.04 COORDINATION

A. Perform Work in cooperation with all other trades in order to secure the best arrangement of the Work. Make no changes in the work without the written approval of the Engineer.

B. Verify that utility requirement characteristics of operating equipment are compatible with utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

C. Coordinate space requirements and installation of mechanical and electrical work, which are indicated diagrammatically on the Contract Drawings. Follow routings shown for pipes, ducts, and conduits as closely as practicable. Place runs parallel.

D. Scaled and figured dimensions shown on Contract Drawings are approximate. Before proceeding with any work, carefully check and verify all dimensions.

E. Equipment size and locations shown on the Contract Drawings are based on the dimensions of a particular manufacturer or dimensions of typical equipment of class indicated. Check the Contract Drawings, as well as actual equipment dimensions, and ensure that the equipment selected will fit into the spaces provided. If required for coordination with other work, or if requested by the Engineer, prepare shop drawings indicating a suitable arrangement of proposed equipment.

1.05 DELIVERY, STORAGE, AND HANDLING

A. For exterior storage of fabricated products, place on sloped supports, above ground.

B. Provide off-site storage and protection when site does not permit on-site storage or protection.

C. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

PART 2 – PRODUCTS

2.01. MATERIALS - GENERAL

A. Provide materials, including auxiliary equipment, unless otherwise noted.

B. Materials shall be of the quality specified. Materials or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job site, but shall be replaced with new material.

C. Verify and certify that items submitted meet the requirements of the Specifications.

D. Equipment installed as part of the Work shall have local representation that can provide local factory authorized service and a local stock of repair parts, unless an exception is approved by the Engineer.

E. Manufacturer for each type of material shall be the same throughout the Work.

2.02 MATERIALS

A. Sleeves for Walls and Slabs: Schedule 40, galvanized steel pipe.

B. Protect metallic structures against corrosion. Provide equipment with manufacturer's standard rust-inhibiting treatment and the finish, unless otherwise specified.

C. Ferrous fittings, such as anchors, bolt rods nuts and miscellaneous parts, except stainless steel fittings, shall be hot dip galvanized.

D. Sealing Compound: An incombustible, permanently plastic, waterproof non-staining compound leaving a finished smooth appearance.

E. Backer: An incombustible fibrous glass recommended for specified application.

PART 3 – EXECUTION

3.01 GENERAL

A. Prior to commencing work of this Section, inspect the installed work of other trades and verify that such work is complete to the point where this installation may commence. Verify that the completed installation conforms to all pertinent codes and regulations, the Contract Drawings, approved submittals, and the referenced standards. In the event of discrepancy, notify the Engineer immediately and proceed as directed.

B. Follow the manufacturers' published directions in installation of piping, equipment, and material, except when otherwise required in the Contract Documents.

C. Install and use material and equipment only in a manner that is approved and recommended by the manufacturers.

D. Do not use aluminum in contact with earth and, at where connected to dissimilar metal without protection with suitable fittings and treatment.

E. Provide anchor bolts for all equipment placed on concrete pads and slabs. Anchor bolts shall be the size and number recommended by the equipment manufacturer, complying with structural calculations, and located by means of templates.

3.02 SLEEVES AND OPENINGS

A. Provide sleeves for each pipe passing through slabs and walls, whether shown on Contract Drawings or not.

B. Set all pipe sleeves and inserts in place before concrete is poured. Coordinate the placing of these items to avoid delaying concrete placing operations.

C. Sleeves for non-insulated pipe shall be two pipe sizes larger than pipe passing through or a minimum of 1/2 inch clearance between inside the sleeve and outside pipe.

D. Length of sleeve as follows:

Sleeve Locations	Sleeve Length
Slabs	Equal to depth of slab construction including finish. Extend minimum of 2 inches above floor level in finished area and in pipe areas.
Roofs	Equal to depth of slab construction including insulation.
Walls	Equal depth of construction and terminated flush with finished surfaces.

E. Seal space between the pipe and the sleeve under all escutcheons with a sealing compound or pack with backer to within 1/2 inch of both wall faces and provide sealing compound on both faces.

3.03 REPAIR AND RESTORATION

A. Repair, grout, refinish, and apply touch-up paint, as necessary to make the facility like new, where structures are affected by the installation of mechanical systems.

3.04 ADJUSTMENT, CLEANING, AND OPERATION PRIOR TO COMPLETION

A. Do not operate any mechanical or electrical equipment without written permission of the Engineer. Supervise such operation continuously. The warranty period shall, however, not commence until the date specified in General Conditions 4.3, Guaranty of Work.

B. Regardless of whether equipment has or has not been operated, clean and adjust equipment before Final Acceptance. Replace filters if equipment has been operated and as otherwise required in the Contract Documents.

3.05 TRAINING

A. When training is required under other Sections of Division 15, provide the training service of a factory trained field service engineer qualified by the manufacture for a one, eight hour working day session at the site to instruct Owner personnel on how to operate and maintain the pump units. This eight hour working day session for training is separate and independent of the requirements set forth for the manufacturer's representative for start-up and testing. Utilize operation and maintenance manuals as instruction documents.

END OF SECTION

SECTION 15060

HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes all the pipe and equipment supports for fire, plumbing and HVAC systems that are indicated on the Contract Drawings.

1.02 REFERENCE STANDARDS

A. American Society of Civil Engineers (ASCE):

1. 7 Minimum Design Loads and Associated Criteria for Buildings and Other Structures

B. American Society of Mechanical Engineers (ASME):

1. B31.9 Building Services Piping

C. American Welding Society (AWS):

1. D1.1 Structural Welding Code - Steel

D. ASTM International (ASTM):

1. A36 Standard Specification for Carbon Structural Steel

2. C1107 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

E. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):

1. SP-58 Pipe Hangers and Supports

2. SP-80 Bronze Gate, Globe, Angle, and Check Valves

3. SP-110 Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

1.03 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.

2. Trapeze pipe hangers.

3. Metal framing systems.

4. Fastener systems.

5. Pipe stands.

6. Pipe positioning systems.

7. Equipment supports.

1.04 DESIGN REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer licensed in the State of California, using performance requirements and design criteria indicated herein.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of all applicable service loads and design seismic events in accordance with ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2. Design equipment supports capable of supporting combined operating loads of supported equipment and connected systems and components.

3. Design seismic-restraint hangers and supports for piping and equipment.

1.05 SUBMITTALS

A. Product Data: For each type of product as applicable.

B. Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer licensed in the state of California responsible for their preparation.

1. Shop Drawings showing support system layout, components, and associate details for trapeze pipe hangers, metal framing systems, pipe stands, and equipment supports.

2. Detail fabrication and assembly of trapeze hangers.

3. Design Calculations: Calculate requirements for designing trapeze pipe hangers, metal framing systems, pipe stands, and equipment supports as applicable.

C. Welding certificates.

1.06 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Finish Coating: Hot dipped galvanized.

3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

4. Hanger Rods and anchor bolts: Continuous-thread rod, anchor bolts, nuts, and washers made of stainless steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2. Hanger Rods and anchor bolts: Continuous-thread rod, anchor bolts, nuts, and washer made of copper-coated steel or stainless steel.

2.02 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from galvanized structural carbon-steel shapes with stainless steel hanger rods, anchor bolts, nuts, saddles, and U-bolts.

2.03 METAL FRAMING SYSTEMS

A. Metal framing systems comprised of pre-fabricated continuous slot metal channel members and accessories shall meet MFMA-4 standards of the Metal Framing Manufacturers Association (MFMA), or standards of other nationally recognized metal framing systems manufacturing associations.

1. Channels: Continuous slotted steel channel with inturned lips.

2. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

3. Hanger Rods and Anchor Bolts: Continuous-thread rods, anchor bolts, nuts, and washer made of stainless steel.

4. Metallic Coating: Hot-dipped galvanized.

2.04 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.05 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

2. Base: Stainless steel.

3. Vertical Members: Two or more stainless-steel, continuous-thread rods.

4. Horizontal Member: Stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

2. Bases: Stainless steel.

3. Vertical Members: Two or more galvanized-steel channels.

4. Horizontal Member: Galvanized-steel channel.

5. Pipe Supports: Stainless steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from galvanized structural-steel shapes, stainless steel continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.06 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from galvanized structural carbon-steel shapes.

2.07 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.

2. 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

A. Provide all stainless steel support materials in lift stations.

B. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

C. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Weld steel according to AWS D1.1/D1.1M if field fabrication is required.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in concrete slabs less than 4 inches thick after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3.02 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.03 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.05 PAINTING

A. Galvanized Surfaces: Clean filed welds and abraded surface areas. Apply galvanizing-repair paint in conformance with ASTM A780.

3.06 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in applicable piping systems and equipment Specification Sections.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Specification Sections.

C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

D. Use carbon-steel metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

E. Use copper-plated pipe hangers for copper piping and tubing.

F. Use padded hangers for piping that is subject to scratching.

G. Use thermal-hanger shield inserts for insulated piping and tubing.

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.

5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.

7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.

11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.

b. Medium (MSS Type 32): 1500 lb.

c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic

test, and load-adjustment capability. These supports include the following types:

a. Horizontal (MSS Type 54): Mounted horizontally.

b. Vertical (MSS Type 55): Mounted vertically.

c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 15140
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section defines the domestic water piping and associated products as shown on the Contract Drawings.

B. Section Includes:

1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.

2. Encasement for piping.

3. Specialty valves.

4. Flexible connectors.

5. Escutcheons.

6. Sleeves and sleeve seals.

7. Wall penetration systems.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM)

B. American Society of Mechanical Engineers (ASME)

C. American Water Works Association (AWWA)

D. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)

E. National Sanitation Foundation (NSF)

F. Plumbing and Drainage Institute (PDI)

1.03 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Domestic water piping and support and installation shall be capable of withstanding the effects of all applicable service loads and design seismic events in accordance with ASCE/SEI 7 "Minimum Design Loads for Buildings and Other Structures."

1.04 SUBMITTALS

A. Product Data: For the following products:

1. Specialty valves.
2. Transition fittings.
3. Dielectric fittings.
4. Flexible connectors.
5. Backflow preventers and vacuum breakers.
6. Escutcheons.
7. Sleeves and sleeve seals.
8. Water penetration systems.

B. Water Samples: Specified in Article 3.16, Cleaning.

C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Fire-suppression-water piping.
2. Domestic water piping.
3. Sanitary Sewerage piping
4. Storm Drainage piping.

D. Field quality-control reports.

E. Grout mix design.

1.05 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 61 National Science Foundation for potable domestic water piping and components.

1.06 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Engineer no fewer than two days in advance of proposed interruption of water service.

2. Do not proceed with interruption of water service without Engineer's written permission.

1.07 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in this section for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 BURIED OR UNDERGROUND PIPE AND FITTINGS

A. Three Inches and Smaller:

1. Pipe: Polyvinyl chloride ASTM D1784 (PVC), ASTM D1785, Schedule 80, Type I, Grade 1.

2. Fittings: ASTM D2466 or ASTM D2467, socket weld, same material and schedule as pipe.

3. Joints: ASTM D2564 and ASTM D2855, socket welded with PVC solvent cement.

B. Four Inches and Larger:

1. Pipe: AWWA C900, Class 200, DR14, per ASTM D2241 polyvinyl chloride (PVC) pipe with bell and spigot ends and flexible ring joints, meeting requirements of ASTM D2241.

2. Fittings: ASTM D1784, Class 12454-A or Class 12454-B, polyvinyl chloride (PVC) fittings, AWWA C900, Class 200, DR14.

3. Joints: ASTM D3139 gasketed bell joints with ASTM F477 gaskets.

2.03 ABOVE GROUND OR EXPOSED PIPE AND FITTINGS

A. Two inches and smaller:

1. Pipe: ASTM B88, Type K, hard copper tubing.

2. Fittings: ANSI B16.18 cast bronze solder fittings, or ANSI B16.22 wrought copper solder fittings and couplings.

3. Unions: one-half inch to two inches in size, provide cast brass, Class 150, with ground joint, brass to brass seat, and solder ends.

4. Joints: Silver-brazed.

B. Two and one half inches and larger:

1. Pipe: ASTM A53, Schedule 40, galvanized, threaded pipes

2. Fittings: ANSI B16.12, ASTM A74, ASTM D2466, and cast iron recessed drainage type threaded fittings.

3. Joints: Threaded and coupled joints, ANSI B1.20.1.

C. Union for connecting steel pipe to copper tubing and tube shall be dielectric union type.

2.04 ENCASEMENT FOR PIPING

A. Standard: ASTM A674 or AWWA C105.

B. Form: Tube.

C. Material: High-density, cross-laminated PE film of 0.004-inch (0.10-mm) minimum thickness.

D. Color: Black.

2.05 SPECIALTY VALVES

A. Comply with requirements in Division 15 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.06 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Capitol Manufacturing Company.

b. Central Plastics Company.

c. EPCO Sales, Inc.

d. Hart Industries International, Inc.

e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

f. Zurn Plumbing Products Group; Wilkins Water Control Products.

2. Description:

a. Pressure Rating: 250 psig (1725 kPa) at 180 deg F (82 deg C).

b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Capitol Manufacturing Company.

b. Central Plastics Company.

c. EPCO Sales, Inc.

d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Factory-fabricated, bolted, companion-flange assembly.

b. Pressure Rating: 175 psig (1200 kPa) minimum.

c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Calpico, Inc.

b. Lochinvar Corporation.

2. Description:

a. Galvanized-steel coupling.

b. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).

c. End Connections: Female threaded.

d. Lining: Inert and noncorrosive, thermoplastic.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Perfection Corporation; a subsidiary of American Meter Company.

   b. Precision Plumbing Products, Inc.

   c. Victaulic Company.

2. Description:

   a. Electroplated steel nipple complying with ASTM INTERNATIONAL F 1545.

   b. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).

   c. End Connections: Male threaded or grooved.

   d. Lining: Inert and noncorrosive, propylene.

2.07 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or engineer approved equal:

   1. Flex-Hose Co., Inc.

   2. Flexicraft Industries.

   3. Flex Pression, Ltd.

   4. Flex-Weld, Inc.

   5. Hyspan Precision Products, Inc.

   6. Mercer Rubber Co.

   7. Metraflex, Inc.

   8. Proco Products, Inc.

   9. Tozen Corporation.

   10. Unaflex, Inc.

   11. Universal Metal Hose; a Hyspan company

B. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

   1. Working-Pressure Rating: Minimum 250 psig (1725 kPa).

2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.

3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

2.08 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.

C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.

D. One Piece, Stamped Steel: Chrome-plated finish with setscrew.

E. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.

F. Split Plate, Stamped Steel: Chrome-plated finish with concealed hinge, setscrew.

G. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

H. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.09 SLEEVES

A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

C. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

D. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.

E. PVC-Pipe Sleeves: ASTM INTERNATIONAL D 1785, Schedule 40.

F. Galvanized-Steel-Pipe Sleeves: ASTM INTERNATIONAL A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.

G. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.10 SLEEVE SEALS

A. Manufacture:

1. Advance Products & Systems, Inc.

2. Calpico, Inc.

3. Metraflex, Inc.

4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

2. Pressure Plates: Stainless steel.

3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.11 WALL PENETRATION SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. SIGMA.

B. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.

1. Carrier-Pipe Deflection: Up to 5 percent without leakage.

2. Housing: Ductile-iron casting with hub, waterstop, anchor ring, and locking devices. Include gland, bolts, and nuts.

3. Housing-to-Sleeve Gasket: EPDM rubber.

4. Housing-to-Carrier-Pipe Gasket: AWWA C111, EPDM rubber.

5. Pipe Sleeve: AWWA C151, ductile-iron pipe.

2.12 GROUT

A. Standard: ASTM C1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 EARTHWORK

A. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install copper tubing under building slab according to Copper Development Association's "Copper Tube Handbook."

C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 15 Section "Domestic Water Piping Specialties" for drain valves and strainers.

D. Install shutoff valve immediately upstream of each dielectric fitting.

E. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

F. Install seismic restraints on piping.

G. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

H. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

I. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

J. Install piping adjacent to equipment and specialties to allow service and maintenance.

K. Install piping to permit valve servicing.

L. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

M. Install piping free of sags and bends.

N. Install fittings for changes in direction and branch connections.

O. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

P. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump.

3.03 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Copper-Tubing, Push-on Joints: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.

H. Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

I. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.04 VALVE INSTALLATION

A. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on

each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.

B. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 15 Section "Domestic Water Piping Specialties."

1. Hose-End Drain Valves: At low points in water mains, risers, and branches.

2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

3.05 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. NPS 1-1/2 and Smaller: Fitting-type coupling.

2. NPS 2 and Larger: Sleeve-type coupling.

3.06 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.07 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

1. Vertical Piping: MSS Type 8 or 42, clamps.

2. Individual, Straight, Horizontal Piping Runs:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.

b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

c. Longer Than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.

2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.

3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.

4. NPS 2-1/2: 108 inches with 1/2-inch rod.

5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

6. NPS 6: 10 feet with 5/8-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Support piping and tubing not listed in this article according to MSS SP-58 and manufacturer's written instructions.

3.08 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

3.09 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors.

B. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.

2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.

5. Bare Piping in Equipment Rooms: One piece, cast brass.

6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.10 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in "Joint Sealants" for joint sealants.

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in "Joint Sealers" for joint sealants.

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using wall penetration systems specified in this Section.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

K. Install sleeve materials according to the following applications:

1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.

2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Stack sleeve fittings.

a. Extend sleeves 2 inches (50 mm) above finished floor level.

b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing

between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.

3. Sleeves for Piping Passing through Gypsum-Board Partitions:

   a. Steel pipe sleeves for pipes smaller than NPS 6 (DN 150).

   b. Galvanized-steel sheet sleeves for pipes NPS 6 (DN 150) and larger.

   c. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.

4. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe.

5. Sleeves for Piping Passing through Interior Concrete Walls:

   a. Steel pipe sleeves for pipes smaller than NPS 6 (DN 150).

   b. Galvanized-steel sheet sleeves for pipes NPS 6 (DN 150) and larger.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials meeting required fire rating.

3.11 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in the center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.12 WALL PENETRATION SYSTEM INSTALLATION

A. Install wall penetration systems in new, exterior concrete walls.

B. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

3.13 IDENTIFICATION

A. Identify system components as indicated on design plans.

B. Label pressure piping with system operating pressure.

3.14 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.

2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.

4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

4. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.

6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.15 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.

2. Open shutoff valves to fully open position.

3. Open throttling valves to proper setting.

4. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.

a. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.

6. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.16 CLEANING

A. Clean and disinfect potable and non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.

b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.

2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.17 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.

2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.

3. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION

SECTION 15145

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Backflow preventers.
3. Wall hydrants.
4. Ground hydrants.
5. Drain valves.
6. Water hammer arresters.

B. Related Sections include the following:

1. Division 15000 Basic Mechanical Requirements for thermometers, pressure gages, and flow meters in domestic water piping, and water meters.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM)

B. American Society of Mechanical Engineers (ASME)

C. ASSE International (ASSE)

D. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)

E. National Sanitation Foundation (NSF)

F. Plumbing and Drainage Institute (PDI)

1.03 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa), unless otherwise indicated.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Installation Standards: Perform installation and testing of work in accordance with the installation instructions and recommendations of the equipment and materials suppliers. Welding material and procedures shall conform to ASME code. Comply with applicable codes and standards listed herein under Reference Standards and Regulatory Requirements.

B. Installer's Qualifications: Plumbers and Pipe Fitters shall be installed under the direct responsible supervision of a plumber licensed by the State of California.

PART 2 – PRODUCTS

2.01 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ames Co.

   b. Cash Acme.

   c. Conbraco Industries, Inc.

   d. FEBCO; SPX Valves & Controls.

   e. Rain Bird Corporation.

   f. Toro Company (The); Irrigation Div.

   g. Watts Industries, Inc.; Water Products Div.

   h. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1001.

3. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.

4. Body: Bronze.

5. Inlet and Outlet Connections: Threaded.

6. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Arrowhead Brass Products, Inc.

    b. Cash Acme.

    c. Conbraco Industries, Inc.

    d. Legend Valve.

    e. MIFAB, Inc.

    f. Prier Products, Inc.

    g. Watts Industries, Inc.; Water Products Div.

    h. Woodford Manufacturing Company.

    i. Zurn Plumbing Products Group; Light Commercial Operation.

    j. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1011.

3. Body: Bronze, nonremovable, with manual drain.

4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.

5. Finish: Chrome or nickel plated.

C. Pressure Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

    a. Ames Co.

    b. Conbraco Industries, Inc.

    c. FEBCO; SPX Valves & Controls.

    d. Flomatic Corporation.

    e. Toro Company (The); Irrigation Div.

    f. Watts Industries, Inc.; Water Products Div.

    g. Zurn Plumbing Products Group; Wilkins Div.

3. Standard: ASSE 1020.

4. Operation: Continuous-pressure applications.

5. Pressure Loss: 5 psig (35 kPa) maximum, through middle 1/3 of flow range.

6. Accessories:

a. Valves: Ball type, on inlet and outlet.

2.02 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cash Acme.

b. Conbraco Industries, Inc.

c. FEBCO; SPX Valves & Controls.

d. Honeywell Water Controls.

e. Legend Valve.

f. Watts Industries, Inc.; Water Products Div.

g. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1012.

3. Operation: Continuous-pressure applications.

4. Size: NPS 3/4 (DN 20).

5. Body: Bronze.

6. End Connections: Union, solder joint.

7. Finish: Chrome plated.

B. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. Ames Co.

b. Conbraco Industries, Inc.

c. FEBCO; SPX Valves & Controls.

d. Flomatic Corporation.

e. Watts Industries, Inc.; Water Products Div.

f. Zurn Plumbing Products Group; Wilkins Div.

3. Standard: ASSE 1013.

4. Operation: Continuous-pressure applications.

5. Pressure Loss: 12 psig (83 kPa) maximum, through middle 1/3 of flow range.

6. Size: on drawings

7. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 (DN 65) and larger.

8. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.

9. Configuration: Designed for horizontal, straight through flow.

10. Accessories:

a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.

b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.03 WALL HYDRANTS

A. Vacuum Breaker Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Arrowhead Brass Products, Inc.

b. Mansfield Plumbing Products LLC.

c. McDonald, A. Y. Mfg. Co.

d. Prier Products, Inc.

e. Smith, Jay. R. Mfg. Co.; Division of Smith Industries, Inc.

f. Watts Industries, Inc.; Water Products Div.

g. Woodford Manufacturing Company.

h. Zurn Plumbing Products Group; Light Commercial Operation.

2. Standard: ASSE 1019, Type A or Type B.

3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.

4. Classification: Type A, for automatic draining with hose removed or Type B, for automatic draining with hose removed or with hose attached and nozzle closed.

5. Pressure Rating: 125 psig (860 kPa).

6. Operation: Loose key.

7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.

8. Inlet: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).

9. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.04 GROUND HYDRANTS

A. Nonfreeze Ground Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Josam Company.

b. MIFAB, Inc.

c. Murdock, Inc.

d. Prier Products, Inc.

e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

f. Tyler Pipe; Wade Div.

g. Watts Drainage Products Inc.

h. Woodford Manufacturing Company.

i. Zurn Plumbing Products Group; Light Commercial Operation.

j. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.21.3M.

3. Type: Nonfreeze, concealed-outlet ground hydrant with box.

4. Operation: Loose key.

5. Casing and Operating Rod: Of at least length required for burial of valve below frost line.

6. Inlet: NPS 3/4 (DN 20).

7. Outlet: Garden-hose thread complying with ASME B1.20.7.

8. Drain: Designed with hole to drain into ground when shut off.

9. Box: Standard pattern with cover.

10. Box and Cover Finish: Rough bronze.

11. Operating Key(s): One with each ground hydrant.

12. Vacuum Breaker: ASSE 1011.

2.05 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.

2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.

3. Size: NPS 3/4 (DN 20).

4. Body: Copper alloy.

5. Ball: Chrome-plated brass.

6. Seats and Seals: Replaceable.

7. Handle: Vinyl-covered steel.

8. Inlet: Threaded or solder joint.

9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.

2. Pressure Rating: Class 125.

3. Size: NPS 3/4 (DN 20).

4. Body: ASTM B 62 bronze.

5. Inlet: NPS 3/4 (DN 20) threaded or solder joint.

6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.06 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AMTROL, Inc.

b. Josam Company.

c. MIFAB, Inc.

d. PPP Inc.

e. Sioux Chief Manufacturing Company, Inc.

f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

g. Tyler Pipe; Wade Div.

h. Watts Drainage Products Inc.

i. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASSE 1010 or PDI-WH 201.

3. Type: Copper tube with piston.

4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Refer to Division 15 Section "Domestic Water Piping" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with requirements of authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.

2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.

3. Do not install bypass piping around backflow preventers.

C. Install outlet boxes recessed in wall. Install 2-by-4-inch (38-by-89-mm) fire-retardant-treated-wood blocking wall reinforcement between studs.

D. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.

1. Install shutoff valve on outlet if specified.

2. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch (38-by-89-mm) fire-retardant-treated-wood blocking wall reinforcement between studs.

E. Install ground hydrants with 1 cu. yd. (0.75 cu. m) of crushed gravel around drain hole. Set ground hydrants with box flush with grade.

F. Install freeze-resistant yard hydrants with riser pipe set in concrete or pavement. Do not encase canister in concrete.

G. Install water hammer arresters in water piping according to PDI-WH 201.

3.02 CONNECTIONS

A. Piping installation requirements are specified elsewhere in Division 15 Sections. Drawings indicate general arrangement of piping and specialties.

3.03 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Reduced-pressure-principle backflow preventers.

2. Outlet boxes.

3. Hose stations.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 15000 Basic Mechanical Requirements.

3.04 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each pressure vacuum breaker reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.05 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION

SECTION 15150

SANITARY WASTE, RAINWATER, AND VENT PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section specifies the requirements for sanitary waste, rainwater drainage and vent piping within 5-foot of buildings and structures, and as indicated on the Contract Drawings.

B. Section includes pipe, pipe fittings, connections, equipment, cleanouts, and interceptors.

1.02 REFERENCES

A. ASTM International (ASTM)

B. American Society of Mechanical Engineers (ASME)

C. Cast Iron Soil Pipe Institute (CISPI)

D. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)

E. Plumbing and Drainage Institute (PDI)

F. UL Solutions (UL)

1.03 SUBMITTALS

A. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes for sewage systems.

B. Product Data: Submit data on pipe materials, fittings, and accessories. Provide manufacturers catalog information. Provide component sizes, rough-in requirements, service sizes, and finishes

C. Manufacturer's Installation Instructions: Submit installation instructions for all material and equipment.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.04 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

1.07 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 – PRODUCTS

2.01 PIPING BURIED, WITHIN FIVE FEET OF BUILDINGS AND STRUCTURES

A. Three inches and smaller pipe:

1. Pipe: Polyvinyl chloride ASTM D1784, ASTM D1785, Schedule 40, Type I, Grade 1.

2. Fittings: ASTM D2467, socket weld, same material and schedule as pipe.

3. Joints: ASTM D2564 and ASTM D2855, socket welded with PVC solvent cement.

B. Four inches or larger pipe:

1. Pipe: Polyvinyl Chloride ASTM D1784, ASTM D2665, standard dimensional ratio (SDR) 26 or thicker, Type 1, Grade 1.

2. Fittings: ASTM F1336, standard dimensional ratio (SDR) 26, with ASTM F477 Gasket, same material as pipe.

3. Joints: ASTM D3034 gasket bell joints with F477 gaskets.

2.02 PIPING ABOVE GRADE

A. Pipe and Fittings: CISPI 301, service weight, plain end hubless cast iron soil pipe and fittings.

B. Joints: CISPI 310, no-hub coupling consisting of neoprene gaskets with stainless steel clamps and bolts.

2.03 FLOOR DRAINS

A. Floor Drain: Zurn No. Z-415SS body assembly with "Type SH" ZB-VP Strainer or Engineer approved equal; coated cast iron body with bottom outlet, combination membrane clamp and adjustable collar with stainless steel medium duty square strainer hinged strainer with vandal proof grate fasteners, and trap primer connection.

2.04 AREA DRAINS

A. Area Drain: Zurn No. Z-415SS body assembly with-"Type SH" ZB-VP Strainer or Engineer approved equal; coated cast iron body with bottom outlet, combination membrane clamp and adjustable collar with stainless steel medium duty square strainer hinged strainer, and vandal proof grate fasteners.

2.05 FLOOR CLEANOUTS

A. Floor cleanouts shall be cast iron with no-hub outlet, brass internal plug and round scoriated tamper resistant nickel bronze top. Zurn No. Z-1400-Z "Level-Trol" Cleanout or Engineer approved equal suitable for installation in concrete floors.

2.06 WALL CLEANOUTS

A. Wall cleanouts shall be Dura Coated cast iron body, cast bronze plug with raised hex head plug and polished stainless steel wall access cover. Zurn No. Z-1468 Wall Cleanout or Engineer approved equal.

2.07 TRAP PRIMERS

A. Trap primers shall be J.R. Smith, Zurn, Josam, PPP or Wade; Engineer approved equal to PPP Electronic trap priming manifold surface mount with NEMA -1 box, ¾" type L copper tubing manifold, ½" compression fittings outlet Circuit breaker, switch timer solenoid valve all tested and certified per UL#73, anti-siphon atmospheric vacuum breaker meets Los Angeles code IAPMO.

B. Automatic Trap Primer: shall be located and installed next to power outlet and plugged in with power cord.

2.08 FIRE STOP SYSTEMS

A. General Purpose Fire Stopping Sealant: Water based, non-slumping, premixed sealant with intumescent properties, rated for 3 hours per ASTM E814 and UL 1479.

B. General Purpose Vibration Resistant Fire Stopping Sealant: Silicone based, non-slumping, premixed sealant with intumescent properties, vibration and moisture resistant, rated for 3 hours per ASTM E814 and UL 1479.

2.09 PIPE FLASHING AND COUNTERFLASHING

A. Vandal proof pipe flashing assembly: Stoneman 1000-6 or -7, or Equal.

B. 24"x24" base pad and counter flashed into pipe.

PART 3 – EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.02 TRENCHING AND BACKFILLING

A. Comply with Sections 02200 "Support of Excavation," 02300 "Earthwork," and 02400 "Utility Jacking and Boring."

B. Locate existing utilities well enough in advance of the excavation to prevent damage during construction. Contractor responsible for any damage whatsoever resulting from his operations on the project

C. Vertically cut pavement prior to excavation and replace in kind after backfill.

D. Test piping prior to backfill.

3.03 INSTALLATION

A. Installation shall be in accordance with Basic Mechanical Requirements 15000.

B. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

C. Provide and install pipe hangers and supports. Provide supporting shoes and anchors at the base of stacks.

D. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings

E. Provide access where valves and fittings are not exposed.

F. All pipes, valves, clean outs, particularly waste piping must be accessible for maintenance. Where recessed in wall cavities provide removable access panels or other approved methods for access.

G. For sanitary waste piping, provide a grade of 1/4" per foot where possible, but in no case less than 1/8" per foot. Install main vertical soil and waste stacks with provisions for expansion and extend full size to roof line as vents.

H. Install vents passing through roof with vandal proof roof flashing and counterflashing assemblies.

I. Pitch all vents for proper drainage. Install vent piping with each bend at a minimum of 45° from the horizontal wherever structural conditions will permit.

J. Sanitary Drains

1. Invert elevations of all sanitary sewer lines leaving the buildings shall be of sufficient depth to permit future connection of a waste line from any point in the lowest level of the building.

2. Connections in waste lines for food service areas shall turn down with a 1/8 bend at the connection to the next branch.

3. Crosses shall not be used in waste piping

K. Provide cleanouts every 50 feet and install at all locations required by code authority having jurisdiction and to permit cleaning of all sewer piping. Provide cleanouts full size of pipe, but not larger than 4".

L. Close cleanout openings with brass screw plugs. Where cleanouts occur in floor, install a brass ferrule complete with a screwed brass cover, flush with floor.

M. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for snaking drainage system.

N. Encase exterior cleanouts in concrete flush with grade.

O. Cushion all traps and bearings to minimize transfer of sound. Firmly anchor all pipes in position.

P. Establish elevations of buried piping outside the building to ensure not less than 3 ft of cover unless otherwise approved by the Engineer.

Q. Install piping penetrating roofed areas to maintain integrity of roof assembly.

R. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

S. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Painting.

T. Install bell and spigot pipe with bell end upstream.

U. Sleeve pipes passing through partitions, walls and floors.

3.04 ERECTION MINIMUM CRITERIA

A. Establish invert elevations, slopes for drainage to at least ¼ per foot minimum. Maintain gradients.

3.05 TESTING

A. Unless otherwise directed, plug all openings and fill with water and test system to the top pressure of 10 feet of head, or as directed by Engineer. Allow to stand one hour or longer as required. Recaulk leaking joints or tighten clamps as directed and then retest.

B. Obtain approval for all work or portions of work as tested, in writing, prior to covering or concealment in any manner. Notify the Engineer at least 2 normal working days prior to testing any portion of work and do not conceal any work until so directed by the Engineer.

END OF SECTION

SECTION 15550

STORM WATER LIFT STATIONS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for packaged storm water pump lift stations, as well as associated force main and appurtenances.

1.02 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. C443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

2. C478 Standard Specification for Circular Precast Reinforced Concrete Manhole Sections

3. D3139 Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

4. F593 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

B. State of California Department of Transportation (Caltrans) Bridge Design Specifications

C. Standard Specifications for Public Works Construction:

1. Section 208-6 Pipe to Manhole Flexible Couplings

D. American National Standards Institute (ANSI)

E. American Water Works Association (AWWA):

1. C508 Swing-Check Valves for Waterworks Service, 2 In. through 24 In. (50-mm through 600-mm) NPS

2. C509 Resilient-Seated Gate Valves for Water Supply Service

3. C512 Air-Release, Air/Vacuum, and Combination Air Valves for Water and Wastewater Service

4. C900 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 12 In. (100 mm Through 1,500 mm)

F. American Water Works Association/American National Standards Institute (AWWA/ANSI):

1. C105/A21.5 Polyethylene Encasement for Ductile-Iron Pipe Systems

2. C110/A21.10 Ductile-Iron and Gray-Iron Fittings

3. C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

4. C150/A21.50 Thickness Design of Ductile-Iron Pipe

5. C151/A21.51 Ductile-Iron Pipe, Centrifugally Cast

6. C153/A21.53 Ductile-Iron Compact Fittings

G. National Electrical Manufacturers Association (NEMA):

1. 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

H. National Fire Protection Association (NFPA):

1. 70 National Electrical Code

I. UL Solutions (UL):

1. 508A Industrial Control Panels

1.03 DEFINITIONS

A. H-20 loading: As defined in Caltrans Bridge Design Specifications.

B. NEMA: National Electrical Manufacturers Association.

1.04 PERFORMANCE REQUIREMENTS

A. Operating Conditions: Each pump shall be capable of delivering scheduled flow at scheduled dynamic head. All openings and passages shall be large enough to permit the passage of a sphere three (3) inches in diameter.

1.05 SUBMITTALS

A. Refer to Section 15000, Basic Mechanical Requirements, for additional submittals.

B. Product Data:

1. Dimensional drawings of lift station drawn to scale indicating components and connections to other equipment and piping.

2. Indicate pump type, capacity, and power requirements.

3. Certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include net positive suction head (NPSH) curve and total dynamic head (TDH) calculations.

4. Include a performance chart for motor showing curves for torque, current, power, factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.

5. Mass moment of inertia calculations for the impellers upon the Engineer's request.

6. Indicate materials of construction.

7. Electrical characteristics and connection requirements.

C. Shop Drawings: The shop drawings shall include the following:

1. Dimensions of sump manhole, equipment, anchors, steps or ladders, pipe supports, attachments, lifting points, tappings, drains, piping, valve, fittings, float switches and access cover and locking hardware.

2. Structural calculations and shop drawings for precast reinforced concrete vaults, manholes and other precast drainage structure components.

3. Any fabricated items not detailed on Contract Drawings.

D. Contract Closeout Information:

1. Operation and Maintenance Data.

1.06 DELIVERABLES

A. Submit certificates of factory and manufacturer's representative's on-site inspection, testing, and approval to the Engineer.

B. Operation and Maintenance Data: Submit as specified in Sections 01700, Contract Closeout, and 15000, Basic Mechanical Requirements. Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

1.07 QUALITY ASSURANCE

A. Notify the Engineer prior to and perform all testing during progress of the work in the presence of the Engineer.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum ten years' experience.

C. Structural calculations and shop drawings for precast reinforced concrete vaults, manholes, and other precast drainage structure components shall be sealed and signed by a registered structural engineer licensed in the State of California.

D. Fabrication, inspection, installation and testing shall comply with all applicable Standards and Codes listed herein.

1.08 WARRANTY

A. Warranty: Submit five year manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

PART 2 – PRODUCTS

2.01 GENERAL

A. Provide lift stations as indicated on plans and specifications.

B. Provide pump station control panel as indicated on plans and specifications.

2.02 TWO-PUMP LIFT STATIONS

A. Equipment and appurtenances for each packaged storm water lift station shall include two pumps, valves, internal piping, central control panel with circuit breakers, motor starters, level controls, radio telemetry equipment, electrical controls and wiring control, electrical service connection, precast concrete wet well and precast concrete valve vault, concrete work and miscellaneous appurtenances required for a complete and operational system. See the Drawings for recommended products.

B. Provide pumps with manufacturer’s name, model number, and rating/capacity as clearly identified on plans and specifications.

C. Provide pumps complete with the following features and appurtenances:

1. Submersible, centrifugal, duplex arrangement, non-clog pumps.

2. Precast reinforced concrete manhole wet well and valve vaults at each pump lift station structure including galvanized steel steps, pipe supports, and all other miscellaneous items required for a complete and operational system.

3. Pump guide rails shall be custom stainless steel construction and shall allow pump lift-out assembly and pump to move from bottom of guide to top of guide without binding. The lift-out assembly shall be constructed to be easily removable from the top of rail.

4. Liquid level sensors, control panels complete with starters, controls, radio telemetry equipment, and LED alarm lights. Include relays, timers, hand-off-auto switch, and monitoring equipment required for a complete and operational system. See the Drawings for recommended products.

5. Plumbing: Provide each pump discharge with a check valve and an isolation gate valve.

6. The motor and pump shall be designed as an integral sealed unit from the factory.

7. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity

2.03 MOTORS

A. Pump Motor: Induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber, NEMA B type. The stator windings and stator leads shall be insulated with moisture resistant Class H insulation rated for 356 degrees F. The stator shall be insulated by the trickle impregnation method using Class H polyester resin resulting in a winding fill factor of at least 95 percent. The motor shall be designed for continuous duty handling pumped media of 104 degrees F and capable of up to 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal sensors set to open at 260 degrees F shall be embedded in the stator lead coils to monitor the temperature of each phase winding. Leakage sensors will detect the presence of water in the oil and stator housing. The sensors will be connected to a factory furnished monitoring unit in the control panels and will actuate an alarm in the monitoring unit when high water levels are detected.

B. The combined service factor shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10 percent. The motor shall be designed for operation up to 104 degrees F ambient and with a temperature rise not to exceed 144 degrees F.

C. The motors and associated cable shall be suitable for installations in a Class 1, Division 2, Group D classified area.

D. Motors shall be sufficiently cooled by the surrounding environment or pumped media. A water cooling jacket shall not be required.

E. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shutoff through run out.

F. Motors shall be capable of continuous submergence to the maximum depth indicated in the Contract Documents without loss of watertight integrity.

2.04 ELECTRICAL CABLE AND PROTECTION

A. Size power cable in accordance with the National Electric Code (NEC) and Insulated Cable Engineers Association (ICEA) standards with sufficient length to reach the junction box above sump pit without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber.

B. The cable entry seal design shall include specific torque requirements to ensure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable.

2.05 BEARINGS

A. The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single deep groove

ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces.

2.06 MECHANICAL SEAL

A. Provide each pump with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in an oil reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the oil chamber, shall contain one stationary and one positively driven rotating tungsten-carbide ring. The upper, secondary seal unit, located between the oil chamber and the motor housing, shall contain one stationary ceramic seal ring and one positively driven rotating carbon seal ring. Each seal interface shall be held in contact by its own spring system. Each pump shall be provided with an oil chamber for the shaft sealing system.

2.07 PUMP SHAFT

A. Pump motor shaft shall be the same unit. The pump shaft is an extension of the motor shaft. Coupling shall not be acceptable. The pump shaft shall be stainless steel.

2.08 IMPELLER

A. Impellers: Gray cast iron, Class 35B, dynamically balanced, double shrouded non-clogging design having a long through outlet without acute turns. The impellers shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in storm water. Impellers shall be retained with an allen head bolt and shall be capable of passing a minimum 3 inch diameter solid. All impellers shall be coated with alkyd resin primer.

2.09 WEAR RINGS

A. A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impellers. The wear ring shall be stationary and made of brass, which is drive fitted to the volute inlet.

2.10 VOLUTE

A. Pump Volutes: Single-piece gray cast iron, Class 30, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller.

2.11 PIPING

A. Piping associated with the plumbing system of the storm water lift station and its discharge pipe shall be ductile iron with mechanical joints for buried service and galvanized steel for exposed service in the sump and the valve vault. Piping shall be in accordance with the requirements specified under Section 15150, "Sanitary Waste, Rainwater, and Vent Piping," and the manufacturer's recommendations.

B. The pump discharge piping embedded in concrete shall be welded steel with flanged ends, hot dip galvanized after fabrication.

C. Size and type of inlet and outlet pipe varies. Refer to Contract Drawings and Section 02630, Storm Drainage System, for the requirements of inlet and outlet piping at sump manhole.

2.12 ELECTRICAL CONTROLS

A. All of the items shall be UL approved and provided with requirements as specified hereinafter.

B. Design a control panel to operate two submersible pumps based on wet well level monitored by level sensors. The pumps shall operate in hand, off, or auto mode. In auto mode, the controller shall turn the pumps on or off based on three level setpoints provided by a submersible pressure transducer. High and low level alarm setpoints shall be provided by in-place corrosion resistant floats. A manual transfer switch and generator receptacle shall enable the use of back-up generator power to pump station in case of utility power failure.

C. Liquid level detection in the wet well shall be achieved by the following devices:

1. Submersible pressure transducer:

   a. Produce 4-20 mA output analog signal that represents liquid level.

   b. Protection to prevent moisture entry into the vent tube.

   c. Shall be suitable for Class 1 Division 2 areas or provide intrinsically safe barrier at control panel.

2. Float-tilt type level switch:

   a. Hermetically sealed.

   b. Contact rated for 4.5 amps at 120 Vac.

D. The pump control panel shall have no live parts exposed to the Operator. Controls shall not be accessible by General Public by either protection with an external cover/housing over controls or controls only accessible inside the lockable enclosure. The pump control panel shall also include the following:

1. Cable-in/cable-out circuit breakers for power distribution.

2. Pump short circuit protection.

3. Pump overload protection.

4. Electromechanical and solid state logic components for interface with wet well level sensors, built-in pump sensors, and selected standard options.
5. Pump and control terminal blocks.

6. Panel mounted LED pilot lights and operators.

7. NEMA 4X padlock enclosures and mounting components. Required size of enclosures shall be determined by Contractor.

8. High Water Alarm: Flashing LED light (red); Low Water Alarm: Flashing LED light (red); Pump No.1 Operating light: Solid LED light (green); Pump No.2 Operating light: solid LED light (green); Pump No.1 Fail light: flashing LED light (red); and Pump No.2 Fail light: flashing LED light (red) to be mounted on enclosure door.

9. Hand-Off-Auto switches and status transformer type LED pilot lights.

10. Utility 120 volts, duplex receptacle.

11. Elapsed time meter.

12. Surge Protection Device.

13 Individual pump across the line starters.

14. Front of panel reset push-buttons.

15. Power fail relay.

16. Controller shall be as indicated on the Contract Drawings or equal.

17. Supervisory relays shall be as indicated on the Contract Drawings or equal.

E. Provide manual transfer switch of the type/size indicated on the Contract Drawings and NEMA type 4X enclosure. Provide weather resistant pin and sleeve generator receptacle by Russellstoll, Appleton, or equal.

F. An RTU shall be provided and installed where indicated on the Drawings to integrate the lift station into a municipal SCADA system. It shall be as indicated on the Contract Drawings or equal.

G. Sequence of operation of duplex controls shall be as follows:

1. When water level in wet well reaches Level Setpoint No. 2 (lead pump start setpoint), the controller provided for charging Pump No.1 and Pump No.2 duty (lead-lag alternating) will change its state and lead pump contactor will be energized. If the water level continues to rise and reaches Level Setpoint No.3 (lag pump start setpoint), the lag pump contactor will be energized until water level drops to Level Setpoint No. 1 (all pumps' stop setpoint). All pump contactors are de-energized at Level Setpoint No. 1 or below.

2. Auxiliary contacts of pump circuit breakers shall be introduced in to the circuitry in such a way that pumps' contactors will be de-energized if circuit breaker trip condition occurs.

3. Auxiliary contacts of thermal overload relays shall be introduced in to the circuitry so that pumps' contactors are de-energized should a motor overload condition occur.

4. If the inflow to the station is greater than the combined capacity of both pumps, the water level will rise to the Level Setpoint No. 4 (high water level alarm) and send a signal to red LED alarm light.

5. Flashing red light LED alarm trouble light indicates any trouble or failure of pumps to drain wet well.

H. Where connection to a municipal SCADA system is required, the Contractor shall engage a systems integration subcontractor responsible for the programming, integration, coordination, testing, and start-up of the control system described in the Specifications and Drawings. The Systems Integrator shall have a minimum of five years' experience with the integration of industrial control systems similar in type to those to be installed in this project. The Systems Integrator is responsible for the following scope of work:

1. City Standards: The Systems Integrator shall conduct up to two workshops to discuss the City's SCADA standards prior to developing SCADA screens.

2. Field Installation: The Systems Integrator shall provide and install all control and telemetry equipment on the field, including but not limited to a complete and operational radio system, RTU, controller, and hardwiring of I/O. The radio system shall have communication ability with the City's existing radio system.

3. Field Programming: The Systems Integrator shall configure the controller to operate in accordance with the control loop descriptions described in the Specification. The Systems Integrator shall configure the RTU to receive inputs and communicate data to SCADA via radio.

4. SCADA Programming: The Systems Integrator is responsible for providing the proper development license(s). The Systems Integrator is responsible for building the required screens using their own development license. The Systems Integrator shall develop pump station screens, using City standards, and coordinate the installation of these screens on the City's existing HMI equipment.

5. Testing and Start-up: The Systems Integrator is responsible for RTU factory acceptance testing and start-up, assisting the Contractor with field I/O verification and testing, verification and testing of a fully operational radio system, and assisting the Contractor with process startup and operation. The control and monitoring of the pump station shall be verified both locally and from the City's SCADA. Test shall include the city alarm and autodialer system for critical pump alarms.

6. Training: The Systems Integrator shall conduct one training workshop to instruct City staff in the operation of the control system.

7. Documentation: The Systems Integrator shall prepare and submit maintenance manuals to the City Representative for preliminary review in three (3) copies and an electronic copy. When the City Representative is satisfied that these are complete and properly prepared, three (3) final sets and an electronic copy shall be delivered to the City. The complete maintenance manual shall contain all the information included in the preliminary equipment submittal, the detailed installation submittal, programming instructions, and the additional information required herein, all bound in hard-cover binders and arranged for convenient use including tab sheets, all indexed and cross referenced, and all final As-Built drawings. The maintenance manuals shall also contain calibration and maintenance instructions, troubleshooting instructions, and instructions for ordering replacement parts.

2.13 PRECAST REINFORCED CONCRETE VAULTS AND MANHOLES

A. Reinforced concrete vaults and manholes shall conform to ASTM International C478 and the applicable material and installation requirements of Sections 02630, Storm Drainage System, and 03300, Cast-in-Place Concrete.

B. Ground Surface Elevation: As indicated in the Contract Documents.

C. Ground Water Table Elevation: Refer to the geotechnical investigation report as referenced in Section 01090 References.

D. Static Loads and Dynamic (Seismic) Loads: Refer to the geotechnical investigation report as referenced in Section 01090 References.

E. Uplift: Buoyance Safety Factor shall be 1.07.

F. Maximum Bearing Pressure: 4000 psf.

G. Excavate and perform backfill operations for vaults and manholes as specified in Section 02300, Earthwork. Unless otherwise noted, place 18-inch deep crushed gravel over the bearing soil to provide a firm-bearing surface for the vault and manhole foundations.

H. Pipe to Precast Reinforced Concrete Sump Flexible Couplings: Shall conform to SSWPC Section 208-6. Couplings shall resist mild exposure to petroleum products.

I. Joints shall be bell and spigot, single rubber O-ring gasketed, conforming to ASTM International C443.

J. Access cover shall be cast iron and designed for H20 loading with lockable hardware.

K. Exterior surfaces of the vault and manhole structures shall receive two coats of Masterseal 581 Thoroseal as manufactured by BASF Corporation, or Engineer approved equal. The concrete surface preparation and application of the above material shall be in accordance with the recommendations of the manufacturer.

L. Provide knockouts in top slab of precast concrete structure to facilitate installation of electrical conduits, vent piping, and other similar protrusions. Coordinate number and size of knockout requirements with storm water lift system equipment. Do not use access cover to facilitate the above.

2.14 VALVE VAULT ACCESS LID

A. Covers: Covers and frames shall be designed for H20 loading and shall be manufactured from ductile iron in accordance with ISO 1083. Covers shall be hinged and incorporate a 90 degree blocking system to prevent accidental closure. Covers shall be one-man operable using standard tools and shall be capable of withstanding a minimum load of 100,000 lbs.

B. Frames: Frames shall be circular and shall incorporate a seating ring, and shall have a 24 inch clear opening. Frame depth shall not exceed 4 inches and frame flanges shall incorporate bedding slots and bolt holes.

C. Security: Covers shall incorporate a spring bar locking system, which automatically activates when the cover is closed. Additional security features shall include a device to prevent the cover from being completely removed from the frame. (This device shall be capable of being deactivated if required).

2.15 PUMP ACCESS HATCH

A. Access Hatch with Fall Protection: Dual-leaf design for H20 loading and of a size as shown on the Contract Documents or the approved shop Drawings.

B. Hatch: Extruded welded steel with an integral anchor flange and seat. Equipped with a flush steel drop handle, which does not protrude above the cover and an automatic hold open arm with red vinyl grip on a release handle. Hinges shall be all stainless steel with tamper proof stainless steel bolts and nuts, and be removable for maintenance after the access door is cast in place. Access door shall be torsion spring assisted with hold open attachments and shall be furnished with slip resistant galvanized diamond plate steel. All parts shall be hot dipped galvanized. The walking surface shall be non-slip and rated for pedestrian service.

C. Fall Protection: Fall protection grating panel(s) shall be aluminum with a powder coat finish that is safety yellow in color. Panel shall be designed to meet the requirements of OSHA standard 29 CFR 1910.23 and be equipped with a hold open device to lock the grating panel(s) in the open position. Hold open device and all hardware shall be Type 316 stainless steel.

D. Security: Access hatch shall be equipped with locking assembly consisting of self latching stainless steel slam lock and with a recessed hasp, so that it can be locked with a padlock. The assembly shall not create obstruction to or be a hazard for pedestrian traffic.

2.16 SOURCE QUALITY CONTROL

A. Perform tests to verify operation of electrical circuits and devices prior to shipment.

2.17 STORM DRAIN FORCE MAIN

A. Materials:

1. Storm Drain Force Main shall be C900 PVC Class 200 and shall be furnished in full compliance with AWWA C900.

2. Joints for PVC pressure pipe shall be the elastomeric gasket type with a pressure rating not less than pipe pressure rating meeting performance requirements of ASTM D3139.

B. Installation:

1. Field threading of PVC pipe will not be permitted.

2. Perform installation procedures, handling, thrust blocking, connections, and other appurtenant operations in full compliance to the manufacturer's printed recommendations and in full observance to plan details when more stringent.

3. Provide reaction blocking, anchors, joint harnesses, or other acceptable means for preventing movement of piping caused by forces in or on buried piping tees, wye branches, plugs, bends, or other joints.

4. Install underground hazard warning tape and locating wire for buried non-metallic piping in accordance with manufacturer recommendations.

2.18 VALVES AND MISCELLANEOUS COMPONENTS

A. General:

1. This section includes valves and miscellaneous items to be installed along the storm drain force main and includes, but not limited to, the following:

a. Resilient Wedge Gate Valves

b. Swing Check Valves

c. Duckbill Style Check Valves

d. Combination Air Release and Vacuum Relief Valves

e. Flange Coupling Adapters

B. Resilient Wedge Gate Valves:

1. Comply with AWWA C509.

2. Materials:

a. Stem and stem nut: Bronze

i. Wetted bronze parts in low zinc bronze.

ii. Aluminum bronze components: Heat treated per AWWA C504.

b. Body, gate: Cast iron.

c. Resilient wedge: Fully encapsulated rubber wedge. Styrene Butadiene Rubber (SBR).

3. Design requirements:

a. Minimum 200 psi working pressure.

b. Buried: NRS, O-ring stem seal, 2 IN square operating nut.

c. Exposed: OS&Y, stuffing box stem seal, handwheel.

d. Counter clockwise open rotation.

e. Fusion bonded epoxy coating interior and exterior except stainless steel and bearing surfaces.

4. Acceptable manufacturers:

a. Clow

b. Mueller

c. M&H

d. Or approved equal.

C. Swing Check Valves:

1. Comply with AWWA C508.

2. Materials:

a. Body and cover: Cast iron.

b. Sear ring, hinge: Bronze.

c. Disc: Cast iron with rubber face.

d. Hinge shaft: Stainless steel.

e. Bearings, connecting hardware: Bronze.

3. Design requirements:

a. Minimum 200 psi working pressure.

b. Furnish with outside weight and lever.

4. Acceptable manufacturers:

a. Clow

b. American Darling

c. Golden Anderson

d. Or approved equal.

D. Duckbill Style Check Valve:

1. Materials:

a. Body: Neoprene

b. Mounting Band: 316 Stainless steel.

2. Acceptable manufacturers:

a. Red Valve Tideflex Valve TF-2

b. Or approved equal.

E. Combination Air Release and Vacuum Relief Valves:

1. Materials:

a. Body and cover: Cast iron.

b. Float: Stainless steel.

c. Seat: Buna-N

2. Design requirements:

a. Size: As shown

b. Working pressure: 150 psi.

c. Capacity: 5 scfm at 1 psi differential.

d. Air vacuum capacity: 1 scfm at 5 psi differential from atmospheric.

e. Provide isolation ball valve.

f. Flush accessories:

i. Blow off valve.

ii. Clear water inlet valve.

iii. Hose and quick connect coupling.

3. Acceptable manufacturers:

a. APCO S-440.

b. GA Industries, Figure 942.

c. Crispin USL20B.

d. Or approved equal.

F. Flange Coupling Adapters:

1. Material:

a. Body: Ductile iron.

b. Gaskets: Styrene Butadiene Rubber (SBR).

c. Restraining bolt, lugs: Ductile iron.

d. T-bolts and Nuts: Stainless steel.

e. Coatings: Fusion bonded epoxy.

2. Design requirements:

a. Supply flanges meeting standards of adjoining flanges.

b. The working pressure rating of the entire assembly shall be greater than or equal to the test pressure specified in Part 3, herein.

c. Provide restraint required to resist lateral forces.

3. Acceptable manufacturers:

a. Romac

b. EBAA

c. Smith-Blair

d. Or approved equal.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Ensure pumps operate at specified system fluid temperature without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of mid-point of published efficiency curve.

B. Coordinate the size of the precast concrete manhole sump structure with the storm water lift station system equipment, including but not limited to pumps, plumbing and electrical components. Ensure that there is adequate space within the structure to remove both pumps and to access the structure to perform periodical maintenance.

C. Install plumbing and electrical components of the storm water pump system in accordance with Section 15150, Sanitary Waste, Rainwater, and Vent Piping, and applicable Sections of Division 16, Electrical.

3.02 START-UP, TESTING, AND INSPECTION

A. Provide services of manufacturer's representative on-site to assist with the start-up, testing, and inspection after the packaged storm water pump system has been installed.

B. The manufacturer's representative test shall include:

1. Megger starter and power cables.

2. Check seal lubrication.

3. Check for proper rotation.

4. Check power supply voltage.

5. Measure motor operated load and no load current.

6. Check level control operation and sequence.

7. Single pump and dual pump operation test on manual and automatically as directed by the level control system.

3.03 FIELD QUALITY CONTROL AND INSPECTION

A. Pressure test entire assembly (pump discharge piping) prior to embedding in concrete.

B. After completion of the work of this Section and with the agreement of the Engineer, place storm water pump system in operation. Acceptance will not be made until the system has operated satisfactorily for a period of not less than 30 days from the date designated by the Engineer. This test period shall be included with the specified contract time. Operation of the system shall not in any way be construed as an acceptance of the system, or any part of it, or as a waiver of any of the provisions of this Contract. The Contractor shall be

responsible for the system during this period of operation. Make any adjustments or repairs which may be required and remedy defects or damages which may occur. The Owner will pay the electrical energy cost consumed by the system during this trial operation.

C. Pressure test storm drain force main in accordance with manufacturer's recommendations and this section.

1. Pressure test requirements:

a. Test Medium: Water.

b. Test Pressure: 125 psi.

c. Test Duration: 120 minutes.

D. Clean all dirt, oil, grease, and other foreign material from the pipe prior to pressure and leakage tests.

E. The Contractor shall furnish and install all temporary testing plugs or caps, pressure pumps, pipe connections, meters, gages, equipment, and labor required to complete the pressure testing.

F. The Contractor shall conduct additional tests and repairs until pipe section passes pressure and leakage tests at no additional cost to the Owner, and without schedule extension.

3.04 TRAINING

A. Provide training for Owner personnel as specified in Section 15000, Basic Mechanical Requirements.

END OF SECTION

SECTION 15750

PACKAGED ROOFTOP AIR CONDITIONING UNITS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for roof mounted, self-contained units, with electric cooling, and electric or reverse refrigeration cycle (heat pump) heating and related controls; including:

1. Packaged rooftop unit
2. Controls
3. Remote panel
4. Roof mounting frame and base
5. Maintenance service

1.02 REFERENCE STANDARDS

A. Air-Conditioning, Heating, and Refrigeration Institute (AHRI)

1. 210/240 Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment
2. 270 Sound Rating of Outdoor Unitary Equipment

B. National Fire Protection Association (NFPA):

1. 90A Standard for the Installation of Air-Conditioning and Ventilating Systems

1.03 SUBMITTALS

A. Product data and schematic layouts showing condensing units, cooling coils, refrigerant piping and accessories required for complete system. Include complete pipe sizing data.

1. Include rated capacities, dimensions, weights, accessories, required clearances, electrical requirements, wiring diagrams and location and size of field connections.

B. Manufacturer's installation instructions

C. Operation and maintenance manual (O&M Manual)

1.04 MAINTENANCE SERVICE

A. Furnish complete service and maintenance of packaged rooftop units for one year from date of substantial completion.

B. Provide maintenance service with a two month interval as maximum time period between calls. Provide 24-hour emergency service on breakdowns and malfunctions.

C. Include maintenance items as outlined in manufacturer's operating and maintenance data including minimum of six filter replacements, minimum of one fan belt replacement and controls checkout, adjustments and recalibrations.

D. Submit copy of service call work order or report and include description of work performed.

1.05 EXTRA MATERIALS

A. Provide one set of filters.

1.06 WARRANTY

A. Provide five-year manufacturer's material replacement warranty for compressor.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Carrier Corp.

B. AAON, Inc.

C. Trane Co.

D. Or Engineer approved equal

2.02 MANUFACTURED UNITS

A. Provide roof mounted units complete with electric heating elements and electric refrigeration as scheduled.

B. Provide units which are self-contained, packaged, factory assembled and prewired consisting of insulated cabinet and frame, supply fan, electric heating elements, controls, air filters, refrigerant cooling coil and compressor, condenser coil and condenser fan.

2.03 MATERIALS

A. Cabinet: Galvanized steel with baked enamel finish, access doors or removable access panels, with quick fasteners, screwdriver operated flush cam type or locking door handle type with piano hinges. Provide structural members a minimum of 18 gage with access doors or removable panels a minimum of 20 gage.

B. Insulation: 1 inch thick neoprene coated glass fiber on surfaces where conditioned air is handled. Protect edges from erosion.

C. Supply Fan: Forward curved centrifugal type, resiliently mounted with V-belt drive, adjustable variable pitch motor pulley and rubber isolated hinge mounted motor or direct drive. Isolate complete fan assembly.

D. Air Filters: 1-inch thick permanent washable.

E. Roof Mounting Frame: 14-inch high galvanized steel channel frame with gaskets and nailer strips.

2.04 EVAPORATOR COIL

A. Provide copper or aluminum tube and aluminum fin assembly with galvanized drain pan and connection.

B. Provide thermostatic expansion valves and alternate row circuiting for units 7-1/2 tons cooling capacity and larger.

2.05 COMPRESSOR

A. Provide the compressor which is hermetic or semi-hermetic, 3600 rotations per minute maximum, resiliently mounted with positive lubrication, crankcase heater, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gage ports, and filter dryer.

B. Delay compressor start with five minute timed off circuit.

C. Provide outdoor thermostat which will energize compressor control circuit above 35 degrees F ambient.

D. For heat pump units, provide reversing valve, suction line accumulator, discharge muffler, flow control check valve and solid state defrost control utilizing thermistors.

E. Provide hot gas bypass or cycling compressors for capacity control.

2.06 CONDENSER

A. Provide coil with copper or aluminum tube and aluminum fin assembly with subcooling rows.

B. Provide condenser fans which are direct drive propeller fans, resiliently mounted with fan guard, motor overload protection wired to operate with compressor.

C. Provide heat pressure control by refrigerant pressure switches cycling the condenser fans for unit operation down to 35 degrees F outdoor temperature.

2.07 SUPPLY/RETURN CASING

A. Dampers: Provide outside, return and relief dampers with damper operator and control package to automatically vary outside air quantity.

B. Gaskets: Provide tight fitting dampers with edge gasket, maximum leakage 5 percent at 2 inches WC pressure differential.

C. Damper Operator: Provide 24 volt with gear train sealed in oil with spring return on units 7-1/2 tons cooling capacity and larger.

2.08 OPERATING CONTROLS - SINGLE ZONE UNITS

A. Electric solid date microcomputer based room thermostat located as indicated in service area with remote sensor located as indicated.

B. Incorporate the following in room thermostat:

1. Automatic switching from heating to cooling
2. Preferential rate control to minimize overshoot and deviation from set point
3. Set-up for four separate temperatures per day
4. Instant override of set point for continuous or timed period from one hour to 31 days
5. Short cycle protection
6. Programming based on weekdays, Saturday and Sunday
7. Switch selection features including imperial or metric display, 12 or 24-hour clock, keyboard disable, remote sensor, fan ON-AUTO switch

C. Include room thermostat display as follows:

1. Time of day
2. Actual room temperature
3. Programmed temperature
4. Programmed time
5. Duration of timed override
6. Day of work
7. System model indication: heating, cooling, auto, off, fan auto and fan on
8. Stage (heating or cooling) operation

2.09 PERFORMANCE

A. Base performance on ARI 210/240 test conditions unless specified otherwise. Sound rating numbers are in accordance with ARI 270.

B. Rated heating and cooling capacities shall be as scheduled on the Contract Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.

B. Verify that proper power supply is available.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions and NFPA 90A.

B. Mount units on factory built roof mounting frame providing watertight enclosure to protect ductwork and utility services. Install roof mounting frame level.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide initial startup and shutdown during first year of operation including routine servicing and checkout.

END OF SECTION

SECTION 16000

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for furnishing and installation of all electrical systems, including the checkout and startup of the systems.

1.02 GENERAL

A. Provisions specified in this Section apply to all of Division 16, Electrical.

B. The types of systems covered by this Section include AC normal and emergency power supply equipment; railroad signals, train control, and communications; station lighting, communications, and amenities; fire alarm systems and power supply to HVAC systems. Systems include electrically driven motors and pumps.

C. The general extent of the electrical work includes furnishing and installing the following items:

1. Raceways, conduit, junction boxes, wire, cable and connectors required to inter-connect and place all equipment in complete operation.

2. Power distribution systems, overcurrent protection, load transfer switches, electrical panels and switchboards, fused and unfused disconnects, receptacle outlets, switching and circuits as indicated on the Contract Drawings.

3. Complete grounding systems.

4. Site electrical service conduits, equipment pads, manholes, handholes, splice boxes, excavation, trenching, backfill and compaction.

5. Lighting including fixtures, lighting poles, outlets, switching and circuits.

1.03 REFERENCE STANDARDS

A. Institute of Electrical and Electronics Engineers (IEEE):

1. 81 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System

1.04 DESIGN REQUIREMENTS

A. Design anchorage and secure electrical equipment in accordance with applicable code. In addition, design anchorage and secure equipment to withstand a lateral force of 0.6 times the weight of the equipment, if such requirement is more stringent.

B. Size conduits, raceways, and junction boxes with minimum 20 percent spare or expansion capacity.

C. Locate electrical equipment in a manner suited to the application and install per the original equipment manufacturers' (OEM) recommendations and applicable code.

D. Provide circuit schedule for all lighting and power panel boards.

E. Unless designed or rated for exterior use or provided with its own housing or enclosure, install electrical equipment in a manner such that it is adequately protected from the local environment (such as rain and dust). Provide temperature controls (ventilating fans or air conditioning) in the enclosed space if the temperature will exceed the OEM recommended operating temperatures.

1.05 SUBMITTALS

A. Material List: Submit list of materials and equipment proposed for use in the work. Except as specified herein for "rough-in" materials, submit complete list at one time and include all proposed alternatives.

1. Include name of manufacturer and where applicable, brand name, type and/or catalog number of each item. Do not list more than one manufacturer for any one item of equipment. Do not list items "as specified", without both make and model or type designation.

2. "Rough-in" materials, such as conduit, fittings, junction boxes, 600V power conductors, and outlets, need not be included in the Material List, provided that these items are as specified and are listed by UL.

B. Shop Drawings and Descriptive Data: As soon as practical after submission of Material List, submit shop drawings and descriptive data of equipment listed hereinafter, and the required wiring diagrams. Include copies of catalog cuts including complete description, information and performance data.

C. Panelboard Directories: Submit for approval.

D. Calculations: Submit structural calculations showing that equipment anchorage will withstand applicable lateral force. Submit other calculations as specified in individual Sections. Calculations shall be signed and sealed by a professional engineer licensed in the State of California.

E. Manufacturer Seismic Qualification Certification: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces according to applicable code and other Contract requirements, whichever is most stringent. Include the following:

1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. The term "withstand" means the unit will remain in place without separation of internal and external parts during a seismic event and the unit will be fully operational after the event.

3. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

4. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Qualifications: Submit evidence of qualifications of electrical field engineer.

G. Test Procedures: Submit test procedures for testing electrical equipment installation and operation.

H. Test Reports: Submit test reports within 30 days of completion of test.

1.06 PROJECT RECORD DOCUMENTS

A. Refer to Section 01720, Contract Record Documents, for general requirements. Mark Project Record Documents daily to indicate all changes made in the field.

1. In addition, indicate on Contract Drawings any changes on equipment locations and ratings, trip sizes and settings on magnetic-only circuit breakers, alterations in raceway runs and sizes, changes in wire sizes, circuit designations, installation details, one-line diagrams, control diagrams and schedules.

2. Accurately record on Contract Drawings the actual locations and exact routing of duct bank. Locate underground conduit stubbed-out for future use, underground feeder conduits, and feeder pull box locations using building lines.

3. Show pull box number, conduit layout with number of bends, total number of cables and wires in each conduit, and indicate spare or empty conduits.

4. Use same symbols as used on Contract Drawings.

1.07 REGULATORY REQUIREMENTS

A. Comply with the following codes and regulatory requirements:

1. California Code of Regulations (CCR)

2. California Public Utilities Commission (CPUC) General Orders and Regulations

3. Institute of Electrical and Electronics Engineers (IEEE):

C2 National Electrical Safety Code

4. National Fire Protection Association (NFPA):

70 National Electrical Code (NEC)

1.08 QUALITY ASSURANCE

A. Field Engineer: Provide a qualified field engineer with a minimum of 10 years of experience in the installation of electrical equipment and systems. The Field Engineer shall perform the following:

1. Prepare detailed Shop Drawings. Review submittals prior to submitting to the Engineer.

2. Inspect equipment for compliance with specified requirements and accepted Shop Drawings at worksite.

3. Prepare field inquiries and work to resolve identified field issues related to installation of electrical equipment and systems.

4. Prepare and coordinate approval with the Engineer any recommended field modifications to controls and equipment received at Worksite.

5. Oversee and monitor electrical work installation, and design and installations of temporary electrical systems in accordance with NFPA 70.

6. Perform or witness specified field tests.

7. Interpret Contract Documents for subordinates.

8. Witness vendor equipment performance tests and inspection.

9. Identify and track work non-conformances and assist with corrective action to remove non-conforming work.

B. Equipment shall be standard products of manufacturers regularly engaged in the production of such equipment and material. In addition to the requirements for an "equal" specified under the General Conditions, for a standard product to be considered an equal to equipment specified, such products shall have been proven in commercial service for a period of at least two years.

1.09 COORDINATION WITH OTHER WORK AND UTILITIES

A. Review civil, architectural, and structural Contract Documents. Plan work to conform to conditions shown and specified to provide the best assembly of the combined work.

B. Work out "tight" conditions in advance.

C. Where the work of several trades is involved, coordinate all related work to provide each system in complete and proper operating order.

D. Coordinate electrical service with utility company, including design and installation of load transfer equipment. Verify with the utility company the available fault current at the incoming service connection point and provide appropriately rated service equipment and overcurrent protection devices.

E. Verify with the telecommunications company their requirements and identify interface points prior to start of work.

PART 2 - PRODUCTS

2.01 NAMEPLATES

A. Equipment Labels and Nameplates:

1. Construction: Laminated phenolic plastic, black front and back, white core, with lettering etched through outer covering. Use 3/16 inch high lettering at push button stations, thermal overload switches, receptacles, wall switches, and similar devices, where nameplate is attached to device plate. Use 1/4 inch high lettering at all other locations, unless otherwise specified or detailed. Engraving directly on device plates with black enamel filled lettering is acceptable in lieu of separate plastic nameplates. Motor nameplates may be of nonferrous metal, 0.03-inch thick minimum, die stamped.

2. Inscription: If detailed on the Contract Drawings, use inscription exactly as shown; otherwise, describe adequately function or use of equipment involved.

   a. For Panelboards and Switchboards: Include panel designation, voltage and phase of supply, e.g., "Panel A, 480/277 V, 3 ph."

3. Provide nameplates on the following equipment:

   a. Metered service pedestal, meter/main service boxes, service switchboards, panelboards, push button stations, control panels, time switches, disconnect switches, thermal overload switches.

   b. Circuit breakers, contactors, or relays in separate enclosures.

4. Fasteners for Nameplates: No. 4 Phillips round head, cadmium plated steel, self-tapping screws, or nickel-plated brass bolts.

B. Circuit Panelboard Directories: Create directory after balancing panel board loads. Provide neatly typed schedule (odd numbered circuits on left side, even on right side) under plastic jacket or protective cover to protect the schedule from damage or dirt. Securely mount on inside face of panelboard door. Briefly and accurately define nature of connected load. Do not use sequentially numbered schedules.

C. One-Line Diagram: Provide approved "one line" for the "As-Built" distribution system.

D. Empty Conduits: Provide tags with typed description of purpose and location of opposite end, wired to each end of conduits.

PART 3 - EXECUTION

3.01 GENERAL

A. Fasten nameplates securely to equipment.

B. Provide pull rope in all conduits, including spare conduits.

3.02 VOLTAGE CHECK

A. At completion of job, check voltage at several points of utilization on the system that has been installed under this Contract. During tests, energize all loads installed.

B. Set taps on transformers to give proper voltage, which is 118 to 122 volts for 120-volt nominal systems and proportionately equivalent for higher voltage systems.

C. If proper voltage cannot be obtained, inform the Engineer.

3.03 FIELD QUALITY CONTROL

A. Perform tests, in accordance with approved procedures, to prove installation is in accordance with contract requirements. Perform tests in the presence of the Engineer, and furnish test equipment, facilities, and technical personnel.

B. Request for Tests: Notify the Engineer a minimum of 24 hours in advance of tests. In the event the Engineer does not witness the test, certify in writing that all specified tests have been made in accordance with the specifications.

C. Deficiencies: Immediately correct deficiencies, which are evidenced during the tests and repeat tests until system is approved. Do not cover or conceal electrical installations until satisfactory tests are made and approved.

D. Tests:

1. Test panel and circuits for grounds and shorts with mains disconnected from feeder, branch circuits connected, circuit breakers closed, all fixtures in place and permanently connected, without lamps, and all switches closed.

2. Test each individual circuit at the panel with equipment connected for proper operation.

3. Ground tests:

a. Ground tests shall meet requirements of CCR, Title 24.

b. Perform fall-of-potential test or alternative in accord with IEEE 81 on the main ground electrode or system.

c. Perform point-to-point tests to determine resistance between main ground system and all major electrical equipment frames, system neutral, and/or derived neutral points.

d. Test Values: Resistance between main ground electrode and ground shall be no greater than 25 ohms. Additional rods shall be installed and bonded to grounding system and driven to a depth of 50 ft. or refusal, whichever comes first. Investigate point-to-point resistance values that exceed 0.5 ohm.

e. Record all test values and submit certified copies to the Engineer.

4. Cables:

a. Make insulation resistance tests on all power cables, using a self-contained instrument such as the direct-indicating ohmmeter of the generator type, or "megger" such as manufactured by J.G. Biddle Company or equal. Insulation resistance values shall be at least 75 percent of shop test records.

b. Apply the following test voltages for one (1) minute, except where specified otherwise herein, in accord with procedure recommended by manufacturer of test equipment and as specified herein.

Rated Circuit Voltage	Megger Voltage (DC)	Min. Megger Reading
600 Volts	500 Volts	600 Kilo-ohms

c. Record all test values and submit certified copies to the Engineer.

d. Replace cables not meeting specified resistance values.

3.04 CLEANING

A. After other work such as sanding, painting, and similar work has been completed, clean lighting fixtures, panelboards, switchboards, and other electrical equipment to remove dust, dirt, grease, or other marks, and leave work in clean condition.

END OF SECTION

SECTION 16060

GROUNDING AND BONDING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section covers the requirements for furnishing, installing and testing of embedded and exposed parts of the grounding system as shown on the Contract Drawings. The requirements shall include grounding and bonding of all elements, such as fences, structures (including OCS Structures), poles, passenger station platform equipment, and impedance bonds.

B. Furnish and install fittings, connectors, equipment and accessories required to complete the grounding system as required and as specified herein.

C. Ground all AC electrical equipment per National Electrical Code (NEC & NESC).

D. Ground the structural steel as shown on the Contract Drawings.

E. Bond major structural frame members to achieve a fully grounded structure.

F. Existing equipment may not require additional grounding if the existing grounding systems meet the intent of the Contract specifications.

1.02 RELATED SECTIONS

A. Section 17060: Grounding of Communications Equipment

1.03 SUBMITTALS

A. Refer to Section 16000, Basic Electrical Requirements, for additional submittals and submittal requirements.

B. Shop Drawings: Submit manufacturer's drawings indicating product material, dimensions and weight, system layout, device mounting and supports, Underwriters Laboratories, Inc. (UL) listing of products.

C. Submit product data sheets that indicate the standards to which the product complies and note the intended application of each type of product for the project.

D. Furnish an overall product listing summarizing in matrix form (a spreadsheet is sufficient) all products against a list of project applications for which individual products will be used.

E. Submit system layout drawings indicating the system level locations type information.

F. Submit test procedures, test forms and list of testing equipment, including test equipment calibration certificates. Furnish examples of each test form with its pass-fail criteria clearly indicated.

1.04 QUALITY ASSURANCE

A. Comply with the following codes and standards. For products covered by other regulatory or industry standards, indicate the agency and standard with all submittals.

1. National Electrical Code (NEC)

2. National Electrical Safety Code (NESC)

3. National Fire Protection Association (NFPA) 101 Life Safety Code

4. UL Solutions (UL)

a.	467	Grounding and Bonding Equipment
b.	869A	Reference Standard for Service Equipment

5. Institute of Electrical and Electronics Engineers (IEEE)

a.	80	IEEE Guide for Safety in AC Substation Grounding
b.	81.2	IEEE Guide for Measurement of Impedance and Safety Characteristics of Large, Extended or Interconnected Grounding Systems
c.	837	IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding
d.	3001.5	IEEE Recommended Practice for the Application of Power Distribution Apparatus in Industrial and Commercial Power Systems
e.	3003.1	Recommended Practice for System Grounding of Industrial and Commercial Power Systems
f.	3003.2	Recommended Practice for Equipment Grounding and Bonding in Industrial and Commercial Power Systems

6. ASTM International (ASTM)

a.	B3	Standard Specification for Soft or Annealed Copper Wire
b.	B8	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
c.	B187	Standard Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with other specified requirements, the following manufacturers offering grounding connectors, conductors, bus bar, rods, and testing services, may be incorporated in the Work:

1. Burndy LLC
2. Erico International Corp
3. General Cable Technologies Corp. (BICC Brand)
4. Hubbell Inc.
5. Thomas & Betts Corp.
6. Copperweld (AFL Wire Products)
7. Or approved equal.

2.02 MATERIAL LIST

A. Furnish annealed, "class B" concentric stranded, bare copper grounding cable of the size shown on the Contract Drawings, and in accordance with ASTM B8 and the NEC.

B. Furnish UL listed ground copper clad solid steel rods, ¾ inch diameter and 10 ft. long (19 mm diameter and 3050 mm in length), with conical driving tips and smooth drive ends, except where rods are to be stacked vertically in which case threaded drive tips and ends shall be utilized. Provide UL listed rod couplers where sectional rods are required. Provide sufficient drive heads or studs of the make and type recommended by the manufacturer to drive the rods without damage to the top of the rods.

C. Furnish copper, long barrel terminal lugs, compression type "YA", manufactured by Burndy LLC or approved equal, correctly sized for the cables indicated in the Contract Drawings.

D. Provide bronze alloy (Everdur or an approved equal) or copper electrical grade hardware for above ground mechanical terminations of grounding electrode conductors, grounding jumpers, or bonding conductors.

E. Provide copper, stainless steel or hot-dipped galvanized hardware for supporting grounding wires at intermediate points on above ground runs.

F. Provide exothermic welds, including required molds and supplies for connection of copper conductors to ground rods below grade, and rods protruding from OCS pole foundations.

G. Provide exothermic welds, including required molds and supplies for connection of copper cable tails to the underside of OCS pole base plates.

H. Provide exothermic welds, including required molds and supplies for the connection of copper cable tails from ground grids to steel structures at passenger stations.

I. Provide exothermic connections for the cross-connections of ground grids and any other buried earthing electrode conductor. Ensure that all ground grid connectors shall meet the requirements of IEEE 837. Exothermic welding process shall consist of standard manufactured molds for each type of weld to be made and powdered metals, which are to be placed in the mold along with the conductors to be welded. Ignition of the powder shall produce molten copper which welds the conductors to each other and to a surface, as the case may be. Exothermic material and products shall be Cadweld as manufactured by ERICO Products Inc., or Thermoweld or approved equal.

J. All exothermic weld materials including welder, weld metal, handles and all other weld materials shall be supplied by the same manufacturer.

K. Provide ground cable terminations at overpass bridges in types as shown on the Contract Drawings. Connections to all structures must be of a type that is designed and approved for the metals and alloys used.

L. Provide the manufacturer recommended anti-oxidation grease for each connection to an aluminum structure or conductor. The same applies for connectors to the OCS static wires.

PART 3 - EXECUTION

3.01 PREPARATION

A. Predetermine if the grounding and bonding to be installed is part of the traction power rail return system (TPRS) and wayside structure (Wayside) or part of general utility grounding. These two types of grounding systems are not to be interconnected. Examples include:

1. OCS Structures and OCS sectionalizing switches: TPRS

2. Wayside fences: Wayside

3. Inter-track fencing posts at passenger stations: TPRS

4. Fencing and guard rails across commuter rail bridges: Wayside

5. Lighting systems under Caltrain rail bridges: Wayside

6. Power taps for signals and communications huts are to have a dedicated ground rod and are not tied to the Traction Power Return System: Wayside

7. Power to interlocking lighting: TPRS

8. Highway signage structures and lighting poles on bridges over Caltrain tracks: Wayside

9. Traction Power Substations and Gantry Structures: TPRS

10. Passenger Station Grounding and Bonding:

    a. Grid under the platform: TPRS

B. Make connection of the neutral points of the rail return impedance bonds to the TPRS according to the detailed signal system shop drawings prepared by the signal system vendor and as diagrammed on the Neutral Return Contract Drawings (if applicable).

3.02 INSTALLATION

A. Furnish, install and test the grounding and bonding of all elements as shown on the Contract Drawings. The work shall include but not be limited to grounding and bonding of fences, structures (including OCS Structures), poles, impedance bonds, passenger station platform structures with ground grids and counterpoise wires, substation equipment and OCS disconnect switches.

B. Connect all electrical equipment enclosures, pipes, conduits and fences, to the nearest ground, whether shown on the Contract Drawings or not. Do not interconnect the TPRS and Wayside grounding systems except as indicated on the Contract Drawings.

C. Establish electrical continuity of pipes and enclosures by bonding except where pipe isolation joints on utility piping are required. Comply fully with Article 250 of the NEC.

D. Remove paint, scale, rust, corrosion, and other foreign matter from the points of contact on metal surfaces before ground connections are made.

E. Secure embedded ground cables and fittings to concrete reinforcing steel with tie wires to prevent displacement during concrete placement. Take precautions to assure that no damage is done to grounding conductors or connections during backfilling, compacting, or concreting operations. Arrange work in such a manner that each part of the grounding system which is laid below finished grade can be completed and inspected before backfilling is done.

F. Allow a free pigtail of sufficient length for all grounding conductors, which are to be extended beyond the concrete surface to reach the point where they are to be connected without splicing. Support exposed grounding conductors on equipment with noncorrosive hardware manufactured of an electrical grade bronze alloy metal, at no greater than 48 inch intervals. Install the wiring such that the ground risers are visible for inspection whenever practicable.

G. Make ground tap connections to equipment at the points provided on the equipment for grounding in accordance with the equipment manufacturer's recommendations. Make connections from ground conductors to the exterior wall of equipment by means of approved bolted fittings.

H. Grounding conductors shall be protected from physical and environmental damage. Wherever possible, exposed grounding and bonding conductors shall be enclosed in a non-metallic raceway. Exposed conductors which must extend from a concrete surface shall be located as close as possible to a corner. Where conductors are required to be exposed, as in the connection to the main ground

bus, grounding conductors shall be supported by corrosion resistant metallic hardware at four feet intervals or less.

I. Apply anti-oxidation grease for mechanical bonding connections to aluminum structures and for each connection to the OCS static wire.

J. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

K. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

L. Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to reduce galvanic corrosion through the use of an appropriate bi-metallic junction that decreases the reaction potential as expressed by a closer spacing in the order of base metals listed in the galvanic series.

2. Make connections with clean, bare metal at points of contact.

3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

M. Grounding Electrode Raceway: A metal raceway containing a grounding electrode conductor shall be bonded at both ends to the grounding electrode conductor. If the grounding electrode conductor is routed in non-continuous metallic conduit, it shall be bonded to the conduit at both ends.

N. Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

O. Moisture Protection: If insulated grounding conductors are connected to ground buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

P. Provide a ground rod in each manhole or handhole as conditions allow, if impractical, locate the required in the immediate vicinity of the manhole or handhole unless noted otherwise, and connect the ground rod and all interior non-current carrying metallic items within the manhole or handhole, including support brackets, pulling irons, and cover frame to the ground inside the manhole/handhole.

Q. Water, gas or other piping shall not be utilized as a ground electrode or ground conductor.

R. Due to the danger of voltage propagation, third-party grounding installations in the vicinity of the ROW shall not be connected to the railway grounding system.

3.03 TESTING

A. Check the continuity of the grounding of each element of the system. Perform the testing and measure the resistances of the ground grids after installation of all elements, such as pole grounds, fences and other grounds that require meeting resistance targets per values specified on the Contract Documents. The ground resistance measurement shall be performed utilizing the "Fall of Potential" method which is considered the most fundamental and general of procedures for ground resistance measurement, except where this procedure is not suitable, such as where stray ground currents (at the same frequency of the Test Meter) are present or if pipes or other conductors are buried near the test electrode. If the "Fall of Potential" test method cannot be utilized because of the electrical connection of the ground mat or rod using non-disconnection hardware the Attached Rod Technique (ART) shall be used to verify compliance of the grounding system.

B. Submit the test procedures, list of cable connecting wires and the test instruments to be used for approval prior to conducting the tests. Record and submit results obtained from these tests.

1. Continuity testing results of conductors, connectors and exothermic welds that indicate connection resistances more than 20% above that of the manufacturer published values are not acceptable. Correct deficiencies.

2. Structure to grounding electrode earth resistance test results more than 10% above the values shown below are not acceptable. Correct deficiencies after first consulting Engineer of Record (EOR).

3. In no case shall tested ground resistances exceed:

   a. Ground grid or surge arrester ground: 5.00 ohms

   b. Fence ground: 25.00 ohms

   c. OCS structure ground: Target resistance of 25.00 ohms

   d. Medium-voltage pad-mounted transformer ground: 5.00 ohms

   e. Medium-voltage pole-mounted transformer ground: 5.00 ohms

   f. Passenger Station Ground Grids and Counterpoise Wires: 5.00 ohms (max). Additional ground rods shall be added to obtain resistance value below this value.

   g. Equipment house for signal and or communication: Ground resistance shall not exceed 15.00 ohms

4. Record each test result for an OCS structure foundation ground specific to each location in table form for review by the Engineer. The target resistance to earth shall be 25.00 ohms.

5. If the testing for electrical resistance of the OCS structure foundations indicates a resistance above 25 ohms the location shall be retested. If the retest indicates a value above 25 ohms, install an additional grounding rod immediately adjacent to the OCS foundation and bonded to the embedded grounding rod. Following the installation of an additional grounding rod the electrical resistance shall be retested to verify the resistance is equal to or less than 25 ohms. If it fails to achieve this value refer the matter to the Engineer for corrective actions to achieve below 25 ohms.

END OF SECTION

SECTION 16100
WIRING METHODS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for wire and cable of 600 volts or less.

1.02 REFERENCE STANDARDS

A. California Code of Regulations (CCR):

1. Title 24, Part 3, California Electrical Code

B. National Fire Protection Association (NFPA):

1. 70 National Electrical Code (NEC)

2. 130 Standard for Fixed Guideway Transit and Passenger Rail Systems

C. UL Solutions (UL):

1. 44 Thermoset-Insulated Wires and Cables

2. 83 Thermoplastic-Insulated Wires and Cables

3. 969 Marking and Labeling Systems

4. 1569 Metal-Clad Cables

5. 1581 Reference Standard for Electrical Wires, Cables, and Flexible Cords

1.03 SUBMITTALS

A. Refer to Section 16000, Basic Electrical Requirements, for additional submittals and submittal requirements.

B. Submit manufacturer's product data for wires and cables, wire connectors, insulating tape, wire markers, and miscellaneous wiring materials.

C. Submit test procedures for verification of circuit operation.

D. Submit results of tests and verification of testing of all electrical systems and circuits.

PART 2 – PRODUCTS

2.01 LABELING AND MARKERS

A. Conductors shall be delivered to the job site plainly marked on 24-inch centers. Markings on cables shall be white lettering with black jacketing for conductor sizes of No. 6 and larger. Indentations for lettering are not acceptable. Markings shall be as follows:

1. Gauge
2. Voltage
3. Kind of Insulation
4. Name of Manufacturer
5. Trade Name

B. Conductor labels shall be with PVC tubing with machine printed black marking. Tubing shall be sized to fit conductor insulation. Adhesive strips are not acceptable.

C. Power and Control Conductors Markers or Labels: Plastic-coated, self sticking markers such as Thomas & Betts E-Z Code or Brady "Perma Code", or field-marked labels such as manufactured by Panduit. Labels shall be permanent and non-handwritten.

2.02 CONDUCTORS

A. Conductors shall be sized according to American Wire Gauge (AWG). Stranding, insulation, rating, and geometrical dimensions shall conform to UL Specifications and bear the label of a nationally recognized testing laboratory.

B. Wire and cable for secondary power, lighting and control circuits shall be rated for 600 V. Use wire with following types of insulation at the specified locations:

1. Dry Locations: Type THHN/THWN or XHHW
2. Wet locations: Type XHHW-2
3. Minimum 75 degrees C temperature rated insulation on conductors, except minimum 90 degrees C temperature rated insulation on conductors in conduits exposed on roof or wet locations.
4. Conductors for general wiring: Insulation rated for 600V manufactured in accordance with UL 44 or 83 as applicable, copper conductors. Cable sizes No. 8 AWG or larger shall be stranded conductors.
5. Conductors in equipment rooms and tunnels shall have low smoke zero halogen properties

6. At Motors and Other Applications Where Subject to Vibration: Stranded conductors

2.03 600 VOLT METAL CLAD CABLE (MC)

A. Lightweight, interlocked steel galvanized armor sheath applied over the cable core in accordance with UL 1569 and NEC Article 330.

B. Cable shall have the required number of conductors and shall include a separate, internal ground conductor, no smaller than indicated on the Drawings. Ground conductor shall meet NEC requirements for equipment grounding conductor.

C. MC cable assembly shall be rated for 90 Degrees Celsius in wet and dry locations.

D. Color coding for conductors shall be as specified in paragraph 3.01 below.

2.04 600 VOLT SERVICE DROP CABLE

A. Service drop cable shall be triplexed, aluminum conductor, 600 volt rated, with 75 Degrees Celsius polyethylene insulation. Messenger wire shall be all aluminum conductor (AAC). Conductor sizes shall be as indicated on the Contract Drawings.

2.05 PULLING LUBRICANT

A. Wire pulling lubricant shall be a wire pulling compound listed by a nationally recognized testing laboratory.

1. Aqua Gel II, as manufactured by Ideal Industries, Sycamore, IL, or Engineer approved equal.

2.06 WIRING MATERIALS

A. Connectors for Copper Conductors No. 10 AWG and Smaller:

1. Pre-insulated Spring Pressure Type: Scotchlok Types Y, R, G and B; Ideal "Wing Nut"; T & B Series PT, or equal.

2. Splice Cap Type: Un-insulated metal cap applied with proper indenter tool which provides deformation of cap in 2 directions at right angles to each other, Buchanan, or Engineer approved equal.

B. Connectors for Fixture Leads: Pre-insulated spring pressure type as specified above for conductors; or set screw type, Marr, Ideal, or Engineer approved equal.

C. Connectors and Lugs for Copper Conductors No. 8 AWG and Larger: Compression type, Burndy, Dossert, T & B, or Engineer approved equal.

D. Watertight Splice Kits: Epoxy resin type, suitable for the type, size and number of conductors being spliced.

E. Splicing and Insulating Electrical Tape (600 V and Below): General purpose electrical tape shall be suitable for temperatures from 18 deg C to 105 deg C and shall be black, ultraviolet proof, self-extinguishing, 7 mil thick vinyl.

F. Washers:

1. Flat washer: Mild steel, tin plated, and slightly larger than Belleville washer.

2. Belleville washer: Either hardened or tempered steel or stainless steel.

PART 3 – EXECUTION

3.01 WIRING METHODS

A. General Requirements:

1. Use No. 12 AWG or larger wire for light and power circuits and No. 14 AWG or larger wire for control circuits, unless smaller wire is specified or shown.

2. Unless otherwise specified or shown, leave at least 9 inches of free conductors at each unconnected outlet. Tape free ends of conductors and coil neatly in outlet box.

3. All cable conductors of 3-phase circuits of single-phase shall be of the same type. Mixing stranded conductors for some phases with others as solid is not acceptable.

B. Splicing and Termination of Conductors:

1. Conductors No. 10 AWG and Smaller:

a. Twist conductors together to be electrically and mechanically secure by means of pre-insulated spring pressure connectors or un-insulated splice caps applied with proper indenter tool designed for the specific type of cap used. Twist conductors together before applying splice caps.

b. Insulate splices, joints and free ends of conductors with insulation equivalent to that of conductors by taping with rubber and friction tapes, or with high dielectric strength plastic tape.

c. If splice caps are used, plastic insulating caps may be used. After applying splice caps, use insulating caps rated for the temperatures to which they may be subjected, and install as recommended by the manufacturer.

2. Conductors No. 8 AWG and Larger:

a. Splice and terminate conductors by means of compression connectors and compression terminal lugs.

b. Do not use split bolt type connectors.

c. After initial set has been taken, retighten all pressure type connectors and lugs.

d. Insulate all splices, joints, and free ends of conductors as specified on this Section.

e. Where aluminum lug is bolted with steel or copper bolt, use Belleville spring washer and flat washer.

3. Underground Splices: Conductor and cable splices installed underground in manholes, pull boxes and similar locations, shall be made watertight.

C. Color Coding:

1. Color code for general wiring as follows:

a. For 240/120V, 1-phase system:
Phase A: Black
Phase B: Red
Neutral: White

b. For 240/120V and 208/120V, 3-phase system:
Phase A: Black
Phase B: Red
Phase C: Blue
Neutral: White

c. For 480/277V, 3-phase system:
Phase A: Brown
Phase B: Orange
Phase C: Yellow
Neutral: Gray

d. Ground conductors:

1) Bare copper conductor may be used for equipment ground only.

2) Insulated ground conductors:
Ground conductor: Green
Isolated ground conductor: Green with white stripe

2. Use green color for any conductor intended solely for equipment grounding, unless it is bare.

3. Use wire with insulation of required color. For other types of wire, which may not be available in specified colors, use self-adhesive wrap-around cloth type markers of solid colors to color code conductors.

4. Where wire markers are used for color coding, mark each conductor at all accessible locations (panelboards, junction boxes, handholes, auxiliary gutters, outlets, switches, control centers and similar devices).

D. Conductor Identification:

1. Feeders: Identify with the corresponding circuit designation at overcurrent device and load ends, at all splices, and in pull boxes.

2. Branch circuits: Identify with corresponding circuit designation at overcurrent device and at all splices.

3. If more than one white (neutral) conductor is present, mark each with all related circuit numbers.

4. Control Wires: Identify with indicated number and or letter designation at all terminal points and connections, including manufacturer pre-wired control sections and cabinets.

5. Alarm and Detection Wires: Identify with indicated wire and mnemonics numbers at all connections, terminal points, and coiled conductors within cabinets.

6. Identify power and control conductors using markers or field-marked labels.

3.02 INSTALLATION

A. Use approved specified wire pulling lubricant. Do not use oil, grease, or similar indiscriminate substances to facilitate the pulling in of conductors.

B. Pull wire into conduits with care and prevent damage to insulation. Use basket pulling grips to avoid slipping of insulation on conductors.

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

D. When pulling conductors, do not exceed manufacturer's recommended pull tension values.

E. Dress harness all wire and cable to prevent mechanical stress on electrical connections. No wire and cable shall be supported by a connection point.

F. Correct the following conditions: Deformed, brittle, or cracked insulation; insulation shrunk or stripped further than 1/8 inches away from the actual point of connection; cold solder joints, flux joints, and solder splatter; ungrommeted, unattached or uninsulated wire or cable entries; and deformation of improper radiusing of wire or cable, especially coaxial cable.

G. Install cable with a bend radius not less than that recommended by cable manufacturer. Provide a box loop for all wire and cable routed through junction boxes or distribution panels.

H. Remove debris and moisture from raceways, boxes, and cabinets before installing wire or cable.

I. Install MC cable at locations indicated on the Contract Drawings or at other locations approved by the Engineer.

J. Service drop cable shall be used only for temporary lighting installation and at other temporary installations as approved by the Engineer.

3.03 FIELD QUALITY CONTROL

A. Prior to operating test, the Field Engineer shall verify that all wiring and connections are done, all circuits are active and working properly, motor phases are wired properly, electrical switches are in the right direction, and that overall the system is ready for application of power and testing.

B. Operating Test: After installation has been completed, conduct an operating test. Demonstrate that equipment operates in accordance with the requirements of this Section. Furnish necessary instruments and personnel required for test.

END OF SECTION

SECTION 16130
CONDUIT AND FITTINGS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes requirements for conduit and conduit fittings. Conduit types shall be as shown on the Contract Drawings and as specified herein.

1.02 REFERENCE STANDARDS

A. American National Standards Institute (ANSI):

1. C80.1 Electric Rigid Steel Conduit

2. C80.3 Electrical Metallic Tubing - Steel

B. ASTM International (ASTM):

1. A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

2. D2564 Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems

C. American Welding Society (AWS):

1. D1.1 Structural Welding Code - Steel

D. California Code of Regulations (CCR):

1. Title 24, Part 3, California Electrical Code

E. Institute of Electrical and Electronics Engineers (IEEE):

1. C2 National Electrical Safety Code (NESC)

F. National Electrical Manufacturers Association (NEMA):

1. TC2 Electrical Polyvinyl Chloride (PVC) Conduit

2. TC3 Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing

G. National Fire Protection Association (NFPA):

1. 70 National Electrical Code (NEC)

H. UL Solutions (UL):

1. 6 Electrical Rigid Metal Conduit – Steel

2. 360 Liquid-Tight Flexible Metal Conduit

3. 651 Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

4. 797 Electrical Metallic Tubing - Steel

1.03 DESIGN REQUIREMENTS

A. In addition to requirements specified in Section 16000, Basic Electrical Requirements, design supports to support the following loads.

1. Support load equal to sum of weights of conduits and wires, and weight of hanger plus 200 pounds.

2. Stress at root of thread of hanger rods: Not more than 9475 psi at design load.

3. Size horizontal member to limit maximum stress of not more than 12,650 psi at design load.

1.04 SUBMITTALS

A. Refer to Section 16000, Basic Electrical Requirements, for additional submittals and submittal requirements.

B. Submit manufacturer's product data for all types of conduit and fittings to be used.

C. Shop drawing information may be combined on a single drawing. Identify each drawing by a number and descriptive title.

D. Submit records of grout quantity installed in casings.

E. Submit test reports.

1.05 DELIVERY, STORAGE AND HANDLING

A. Install thread protectors both ends of galvanized rigid steel conduits for shipment and handling.

B. Package couplings separately.

PART 2 - PRODUCTS

2.01 GENERAL

A. Conduit and conduit fittings shall be standard types and sizes as manufactured by a nationally recognized manufacturer of this type of materials, and be in conformity with standards.

2.02 RIGID GALVANIZED STEEL CONDUIT (RGS)

A. Provide conduit, couplings, elbows, bends, sealing fittings, and nipples conforming to ANSI C80.1 and UL 6, with each length bearing manufacturer's stamp and UL label.

B. Couplings, locknuts, and all other fittings shall be galvanized, waterproof, and threaded type only.

C. Bushings shall be nylon insulated metallic and grounding type.

D. Furnish conduit straps, clamps and clamp backs made of galvanized malleable iron.

2.03 POLYVINYLCHLORIDE (PVC) CONDUIT

A. Schedule 40 and schedule 80 rigid polyvinyl chloride electrical conduit conforming to the requirements of EPC-40-PVC and EPC-80-PVC conduit of NEMA TC 2 and fittings for EPC-40-PVC and EPC-80-PVC conduit of NEMA TC 3 and listed by UL for direct underground burial, manufactured from high impact, non-conducting, self-extinguishing material.

B. Couplings, Adapters, Expansion Fittings: Conform to same requirements as rigid PVC conduit. Use solvent cement for PVC joints, as recommended by conduit manufacturer.

C. Bends: Factory made PVC bends.

D. PVC conduits shall be Schedule 40 throughout the Work, except conduits subject to regular vehicular loads at rail crossings and in parking lots, which shall be PVC Schedule 80.

E. UL 651 listed and in accordance with NEC Article 352 for underground use.

F. Solvent for welding PVC shall comply with ASTM D 2564 or approved equal.

2.04 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. LFMC shall be a flexible steel conduit with PVC jacket and complying with UL 360.

2.05 ELECTRICAL METALLIC TUBING (EMT)

A. EMT shall comply with ANSI C80.3 and UL 797.

2.06 PULL CORD

A. Pull Cord or Rope: Twisted or braided nylon cordage, 1/4 inch diameter, with a minimum tensile strength of 1000 pounds. Pull cord shall be combination footage measuring tape and pull line.

2.07 MANDRELS

A. High-strength aluminum alloy with steel center rod and cast iron eyes.

B. Use solid cylindrical type mandrels, minimum 12 inches long and 1/4 inch less than diameter of duct at center, tapering to 1/2 inch less than duct size at ends.

2.08 CONDUIT SUPPORTS

A. Steel shapes, angles and channels: 1 1/2 by 1 1/2 or 1 5/8 by 1 5/8 inches, 12 gauge, cold-formed, lipped channel; designed to accept special spring-held hardened steel nuts for securing hanger rods and other attachments.

B. Single Conduit Hangers: Steel City No. C-149, Unistrut No. J1205 through J1260, or Engineer approved equal, with 3/8 inch minimum diameter steel rod.

C. Riser Supports: Steel City No. C-210, or Engineer approved equal.

2.09 REINFORCED PLASTIC MORTAR SPACERS (RPM)

A. Duct Spacers: Refer to Section 02500, Underground Ductwork and Structures.

B. Bore spacers shall be made from high density polyethylene (not less than 0.96 specific gravity), as manufactured by Formex Manufacturing, Inc., Underground Devices Inc., or Engineer approved equal.

C. Steel Bands and Polypropylene Straps for Securing Ducts in Bore Spacers: Provide means of securing conduits to bore spacers in accordance the bore spacers manufacturer's written instructions. At minimum provide one of the following means:

1. 5/8 inch by 0.30 inch galvanized steel bands and buckles having a minimum breaking strength of 1405 lbs.

2. 3/4 inch wide polypropylene strapping having a 1400 lb breaking strength, 7 percent maximum stretch, and steel seals.

2.10 UTILITY MARKER TAPE

A. Tracer Tape: As specified in Section 02300, Earthwork. Use in trenches containing electric and power circuits. Tape shall have printed warning that an electric circuit is located below the tape.

2.11 CONDUIT EXPANSION FITTINGS

A. Fabricate from material similar to type conduit with which used.

B. Include factory installed packing ring and pressure ring; prevent entrance of moisture.

C. Include grounding ring or grounding strap for metallic expansion couplings.

2.12 INSERTS

A. Channel Inserts:

1. Fabricate from cold-formed steel channels 12 gauge or thicker; overall size 1 1/2 inches by 1 1/2 inches or 1 5/8 inches by 1 5/8 inches; lengths as indicated. Hot-dip galvanize after fabrication in accordance with ASTM A153.

2. For Embedding in Concrete:

a. Fabricate from channels having a solid base

b. Weld concrete anchors to channel during fabrication and before coating

c. Clean and galvanize after fabrication

d. Provide assemblies with minimum pull-out load rating of 4500 pounds per linear foot uniformly distributed.

e. Furnish channel inserts for embedded installation in concrete with channel interior completely filled with Styrofoam.

3. For Surface Mounting:

a. Fabricate from channel with 3/8 inch by 3 inches slots on 4 inches centers in base.

b. Galvanize inserts for surface mounting on concrete surfaces, and for installation in damp or wet areas in accordance with ASTM A153.

c. Use galvanized expansion shield type anchor bolts.

B. Spot Inserts for Embedding in Concrete:

1. Steel, galvanized after fabrication in accordance with ASTM A 153.

2. Design for maximum loading of 800 pounds with safety factor of three.

3. Knockout openings: Designed to accommodate square or rectangular nuts.

2.13 FILLING MATERIALS

A. Furnish fire-resistive filling material for openings similar to the material of the floor, wall or ceiling being penetrated, and finish to prevent passage of water, smoke and fumes.

B. Where conduits passing through openings are exposed in finished rooms, use filling material that matches the adjoining finished floor, ceiling, or wall.

2.14 END CAPS

A. Provide end caps at both ends of all empty conduits.

2.15 CASINGS

A. Casing to receive bore spacers and ducts shall be a minimum of 0.375 inch thick steel wall and shall be straight and true.

PART 3 – EXECUTION

3.01 GENERAL REQUIREMENTS

A. Apply raceway products as specified below, unless otherwise indicated:

1. Outdoors:

   a. Exposed: Rigid Galvanized Steel

   b. Underground: Schedule 40 PVC. Conduit shall be buried not less than 42 inches below finished grade.

   c. Underground at Rail Crossings and areas subject to regular vehicular traffic (such as parking lots): Schedule 80 PVC. Conduit shall be buried not less than 42 inches below finished grade.

   d. Embedded in Concrete: Schedule 40 PVC.

2. Indoors:

   a. Exposed, not subject to physical damage: Electrical Metallic Tubing or Rigid Galvanized Steel

   b. Exposed, subject to physical damage: Rigid Galvanized Steel

   c. Connection to Vibrating Equipment: Liquidtight Flexible Metallic Conduit

   d. Concealed in Ceilings and Interior Walls: Electrical Metallic Tubing

   e. Damp or Wet Locations: Rigid Galvanized Steel

B. For system voltages higher than 150 volts to ground, maintain continuity of equipment ground across flexible conduit connection to motor outlet by installing bonding wire inside conduit and connecting each end of wire to outlet or junction boxes by separate bolt, or use liquid tight flexible conduit approved for this purpose.

C. For PVC conduits, maintain continuity of conduit system ground by installing copper grounding wire inside PVC conduit, per CCR, Title 24. Ground this wire at each accessible location (manhole, pullbox, cabinet, outlet and junction box, and similar locations) and at each termination.

D. Check embedded items for correct location and detail before concrete is placed.

E. Control erection tolerance requirements; do not impair strength, safety, serviceability, or appearance of installations. Determine exact locations of conduit.

F. Install trade size, type, and general routing and location of conduits, raceways, and boxes as indicated or specified.

G. When exposed or buried conduit passes through expansion or contraction joint in structure, install conduit at right angles to joint; provide approved conduit expansion fitting at joint.

H. Provide expansion fittings in conduit runs as required to compensate for thermal expansion.

I. Conduits exposed to different temperatures: Seal to prevent condensation and passage of air from one area to the other.

J. When field cutting of conduit is required, remove rough edges. Where conduit enters box or other fitting, provide bushing to protect wire from abrasion.

K. Provide a minimum slope of three inches to each 100 feet away from buildings and towards manholes or pull boxes; run in straight lines between indicated changes in direction.

L. Perform welding in accordance with AWS D1.1.

3.02 EXCAVATION, TRENCHING, AND BACKFILL

A. As specified in Section 02300, Earthwork, and as indicated in the Contract Documents.

3.03 REINFORCED PLASTIC MORTAR SPACERS (RPM)

A. Duct Spacers: Refer to Section 02500, Underground Ductwork and Structures.

B. Bore Spacers (For ducts installed inside casing):

1. Use one double wall bore spacer for every 5 feet of duct bank.

2. Construct a trough or feeder bridge at the leading end of the casing to support sections of duct bank as they are assembled and pulled into the casing.

3. Use "Off Center Weight Technique" or "Stabilization Cables" to prevent rotating of the duct bank (corkscrew) as it is pulled through the casing.

4. Hold bore spacers in place relative to the conduit to avoid excessive temporary thrust load on each bore spacer while grout is pump into the casing.

5. Hold duct bank in position at both ends to accommodate possible uneven thrust loads that may be generated during the grouting operation.

6. Do not exceed the hydraulic collapse pressure of the conduits during grouting operation.

7. Measure and record actual quantity of grout used.

8. Secure conduits to bore spacers by installing on each side of each bore steel bands and buckles or polypropylene strapping and steel seals.

3.04 UNDERGROUND CONDUITS

A. Refer to 02300, Earthwork, for provisions for trenching, backfilling, and tracer tape.

B. Verify conduit is continuous and not damaged by pulling mandrel through embedded conduit within five days after concrete placement.

C. Cap or plug ends of conduit with permanent cap or plug. Do not use duct tape to temporarily seal conduit. Prevent concrete and other materials from entering and obstructing conduit. Do not install bell end fittings on conduits in ungrounded pull boxes.

D. Sandpaper joints in PVC conduit; remove burrs, clean and dry joints, and brush with solvent cement recommended by manufacturer.

E. Heating or any other method shall not be used to produce a larger bend. A sweep radius shall never be less than 15 feet in any given section.

F. Install duct runs straight and true between pull boxes. Do not use bends except where shown on the Contract Drawings. For alignment curves, do not use more than 5 degree segments for each standard straight length.

G. Conduits smaller than three inches: Make horizontal and vertical changes in direction exceeding 10 degrees by long sweep bends; having minimum radius of 25 feet. Manufactured bends may be used at ends of short runs of 100 feet or less, but only at or within five feet of end of run. Sweep bends may be made up of curved or straight sections, or combinations. Manufactured bends: bend radius to centerline of all conduits not less than 10 times nominal diameter of conduit for ducts of three inches in diameter and larger.

H. Place underground raceways at minimum depth of 42 inches to top of sand encasement, or to top of conduit (as applicable), unless specifically indicated otherwise.

I. Plug all ends of unused ducts and conduits in pull boxes/manholes. Use plugs manufactured for the purpose.

J. Unless otherwise shown on the Contract Drawings, install an expansion joint with minimum range of 5 inches in every 100-foot length of PVC type conduit. Make

all joints in PVC conduit with solvent cement, as recommended by conduit manufacturer.

K. During non-work hours, and at locations where installation of ducts is temporarily suspended or terminated, close ends of ducts with caps or plugs fitted to prevent entry of water or debris. Use caps or plugs designed for purpose by conduit manufacturer.

L. Inspect ducts and couplings to ensure only clean and undamaged units are incorporated in Work.

M. Refer to Article entitled Mandrel.

N. Provide flared bell ends on conduit and ducts entering manholes, handholes, and pull boxes.

O. Conduit runs shall have no more than three (3) 90 degree bends between pull boxes, between manholes, and from point to point from the last pullbox.

3.05 UNDERGROUND CONDUITS FOR COMMUNICATIONS

A. Conduit bends shall be in accordance with NEC and the California Electrical Code, with not more than 120 degrees in bend. Where more bends are required in a particular run, install pull boxes as required to facilitate pulling conductors. For straight conduit runs, maximum length without a pull box/manhole shall not exceed 500 feet. For conduit runs with some bends, maximum length without a pull box/manhole shall not exceed 400 feet.

B. Conduit stacks shall begin sweeps a minimum of 10 feet from exterior pull box face, leaving 10 feet of straight conduit perpendicular to cored entrance holes of pull box. Transition of conduits from underground to side of pull box shall be ”S” shaped as shown on communications Standard Drawings.

C. When conduit stack enter or exit in a straight line to a pull box face, conduit stack shall separate from common trench at a minimum distance of 30 feet from entrance to pull box.

D. When conduit stack enter or exit from sweep to a manhole, conduit stack shall separate from common trench at a minimum distance of 35 feet perpendicular to entrance of pull box.

E. Communication conduit stack shall contain 2 inch, 3 inch and 4 inch conduits as shown in the Contract Documents.

F. All conduits shall be 15-foot minimum radius in any given section of the 90 degrees conduit sweep. 90 degrees conduit sweep shall be manufacturer-supplied bends of 20 foot length. Determine the total sweep radius by the maximum natural bending capability of each twenty-foot section.

G. Terminate underground conduit stubs with coupling and threaded plug.

3.06 EXPOSED CONDUITS

A. Install conduits straight and true with respect to each other and adjacent construction.

B. Exposed conduits in Public Areas shall be painted to match surrounding areas.

C. Route exposed conduits in such a manner as to obtain the least visibility from public view, along columns and beams, and similar features. Verify routing with the Engineer.

D. Provide separable watertight hub fittings with gasket, separate nylon insulated throat and case hardened locknut.

3.07 SUPPORTS

A. Support conduits in vertical runs not to exceed 5-foot intervals. Use riser supports with clamps for vertical conduit risers.

B. For single conduit runs, use pipe straps with single conduit hangers. Single hole malleable iron clamps may be used for horizontal runs on vertical surfaces. Perforated strap (plumber's tape) is not acceptable.

C. Multiple Pipe Hangers (Trapeze Type):

1. Fabricate two or more steel hanger rods, a steel horizontal member and U-bolts, clamps, and/or other attachments necessary for securing hanger rods, cable trays and conduits.

2. Hanger Rod – Not smaller than 1/4 inch diameter, threaded full length.

3. Horizontal Member: Steel angles, and channels. Two or more channels may be welded together to form horizontal members of greater strength.

3.08 MANDREL

A. As each section of conduit and duct line is completed between manholes, handholes, and pull boxes, pull mandrel and swab through conduit or duct to remove foreign matter.

B. Draw mandrel through completed conduit run manually without mechanical assistance. If obstructions are encountered which cannot be removed or if conduits do not pass the "usable capacity" mandrel, correct or replace conduit.

C. Correct or replace conduits which have a consistent "hard spot" (indicating possible separation), conduits where joints may damage cable sheaths, or conduits with misaligned junctions or poor conduit joints.

D. During construction, protect partially completed duct lines from entrance of debris by means of suitable caps or plugs.

3.09 PULL CORDS

A. Install pull line in empty (unused/future) conduits. Make pull-line continuous from outlet to outlet, with two (2) feet of slack at each outlet.

B. After conduits are cleaned and mandrelled, install rope and securely seal both ends of conduit with caps.

C. Do not splice pull cords. Leave ample slack length at each end of pull cords.

3.10 FILLING OF OPENINGS

A. Wherever slots, sleeves or other openings are provided in floors or walls for the passage of raceways, including bus ducts, fill such openings as follows:

1. Install fire-resistive filling material to prevent passage of water, smoke and fumes.

2. Where conduits passing through openings are exposed in finished rooms, use filling material that matches, and is flush with, the adjoining finished floor, ceiling or wall.

3.11 CASINGS

A. Install casing in which bore spacers and ductwork will be installed so that inside walls are smooth and free from ridges, projections and seams that might impede the rolling of wheels of bore spacers.

3.12 FIELD QUALITY CONTROL

A. Notify the Engineer for inspection and sign-off of the following installations:

1. Conduits to be direct buried: Notify the Engineer prior to covering.

2. Completed underground installations: Obtain the Engineer's inspection and acceptance before installation of cable and equipment.

3. Conduits to be embedded in concrete: Obtain the Engineer's inspection and acceptance before pouring concrete.

4. Mandrelling and swabbing (to be witnessed by the Engineer).

5. Installation of pull cords (to be witnessed by the Engineer).

B. Document each mandrelled or swabbed conduit and submit test report.

END OF SECTION

SECTION 16135
OUTLET, JUNCTION AND PULL BOXES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for boxes for use with wiring devices and lighting fixture outlets.

1.02 REFERENCE STANDARDS

A. California Code of Regulations (CCR):

1. Title 24, Part 3, California Electrical Code

B. National Electrical Manufacturers Association (NEMA):

1. FB-1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable

2. OS-1 Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

3. 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

C. National Fire Protection Association (NFPA):

1. 70 National Electrical Code (NEC)

D. UL Solutions (UL):

1. 514A Metallic Outlet Boxes

1.03 SUBMITTALS

A. Refer to Section 16000, Basic Electrical Requirements, for additional submittals and submittal requirements.

B. Submit manufacturer's product data on boxes to be used.

PART 2 – PRODUCTS

2.01 GENERAL

A. Furnish electrical boxes of material, finish, type and size indicated and required for location, kind of service, number of wires, and function.

B. Boxes shall have appropriate means to secure covers. Provide boxes complete with accessible covers designed for quick removal and suitable for purpose used; equip boxes, in which or on which no devices or fixtures are to be installed with flat or raised blank covers as required.

C. Provide neoprene gaskets 1/8 inch thick for boxes subjected to weather.

D. Provide fire resistant gaskets 1/8 inch thick for boxes in tunnels and cross-passages.

E. Furnish necessary adapter plate for mounting devices on light fixtures, brackets, supports, hangers, fittings, bonding jumpers and other accessories required.

F. Concealed and Embedded Junction Boxes: Zinc-coated inside and out.

2.02 STANDARD SHEET METAL BOXES

A. Standard Sheet Metal Boxes: Conform to NEMA OS-1 standard, hot dipped galvanized, one piece drawn steel.

B. Outlet Boxes shall be 4 inch minimum true size and 1-1/2 inches minimum depth unless otherwise specified for the installation. For 1-inch conduit, use boxes 4-11/16-inch minimum trade size. Sectional boxes assembled by means of screws are not acceptable.

C. Use standard galvanized covers, rings and fittings of appropriate type for box or device to be installed. Same thickness as sheet steel boxes.

D. Provide products of commercial quality best suited for purpose indicated or specified.

E. Luminaire and equipment supporting boxes shall be rated for weight of equipment supported.

F. Manufacturer: Appleton, Raco, Steel City, or Engineer approved equal.

2.03 CAST BOXES

A. Cast Boxes: Conform to NEMA FB-1. Boxes for exposed switches and receptacles: Cast metal, FS and FD Types.

B. Boxes shall be cast metal type with threaded hubs. Steel or ferrous alloy, with compatible conduit fittings.

C. Use cast metal boxes in moist locations where surface mounted rigid conduit system is used (e.g. storm water lift station sump, above ground prefabricated service booth on interior and exterior surfaces, and for surface mounted weatherproof outlets or devices, regardless of location)

D. Surface Mounted Cast Metal Box: NEMA 250, Type 4, 4X or 6, flat flanged, galvanized cast iron. Furnish cover with ground flange, neoprene gasket, and stainless steel cover screws.

E. Recessed Mounted Cast Metal Box: NEMA 250, Type 3S, heavy duty, galvanized cast iron, recessed cover with neoprene gasket suitable for concrete wall embedment. Cover shall be provided with stainless steel tamper proof screws. Box shall be drilled and tapped for the number and size of conduits indicated on the Contract Drawings. Use box in tunnels and pedestrian underpasses.

F. In-Ground Cast Metal Box: NEMA 250, Type 6, inside flanged, recessed cover for flush mounting. Galvanized cast iron. Non-skid cover with neoprene gasket and stainless steel screws.

G. Cover Legend: "ELECTRIC"

H. Manufacturer: Appleton, Crouse-Hinds, or Engineer approved equal.

PART 3 - EXECUTION

3.01 OUTLET BOXES

A. Outlet boxes

1. Securely fasten outlet boxes in position and support independent of the conduit system.

2. Install boxes true to the building lines and at equal heights in conformity with mounting heights per NEC and as indicated in the Contract Documents.

3. Boxes shall have only the holes necessary to accommodate the conduits at point of installation.

4. Rigidly secure boxes in position. Set boxes so that the front edge of the box is flush with the finished wall or ceiling line, or not more than 1/8 inch back of same.

5. Offset back-to-back outlets so that a minimum of 6 inches separation is provided.

6. All boxes shall be accessible. Mount boxes with long axis of devices vertical unless otherwise indicated.

7. Locate boxes and box knockouts without interference with reinforcing steel.

B. Lighting Outlet Boxes

1. Exposed installation: Cast metal, not smaller than 4 inches round or square by 2 1/8 inches deep.

2. Embedded and concealed installation: Standard sheet steel boxes approved for intended purpose.

3. Locate outlet boxes to allow luminaries positioned as shown on reflected ceiling plan.

C. Support fixture outlet boxes installed in suspended ceilings supporting acoustical tiles or panels, directly from the structure above, wherever pendent mounted lighting fixtures are installed on the box. Mount boxes independent of ceiling suspension system.

D. Install necessary adapter plate for mounting devices on light fixtures, brackets, supports, hangers, fittings, bonding jumpers and other accessories.

E. Install specified gaskets.

F. Grounding: As specified in Section 16060, Grounding and Bonding. Install grounding jumpers.

3.02 JUNCTION AND PULL BOXES

A. Junction and pull boxes less than 100 cubic inches in size: Cast metal for exposed installation and sheet steel for embedded installation.

B. Junction and pull boxes more than 100 cubic inches in size: Conform to requirements for cabinets, except use recessed cast metal boxes with gasketed covers in tunnels; interface pull boxes at ends of tunnels.

C. Support boxes independently of conduit.

D Use gang boxes where more than one device is mounted together. Do not use sectional box.

E. Install covers readily accessible after completion of installation.

F. Outlet boxes used as junction boxes: Not smaller than four inches square by 1 1/2 inches deep. Provide flat blank covers.

G. Covers:

1. Same thickness as sheet steel boxes; secured in position by No. 10-24 stainless steel machine screws. Arrange covers to be vandal resistant.

2. Cover for four-inch square box: Provide opening at one side for switch or receptacle; blank at other side.

H. Concealed and Embedded Junction Boxes:

1. Concealed or embedded switch or receptacle boxes: Sheet steel, four inches by 1 1/2 inches deep minimum size.

2. Boxes Set in Concrete:

a. Support boxes to prevent movement during placement of concrete.

b. Plug and mask unused nailing holes and other holes in side or bottom of boxes.

3.03 CLEAN UP

A. After installation, clean boxes placed in concrete.

END OF SECTION

SECTION 16140

CONCRETE HANDHOLES AND PULL BOXES

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes requirements for handholes and pull boxes. Handholes and pull boxes are both referred to in this Section as handholes.

1.02 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1. M199 Standard Specification for Precast Reinforced Concrete Manhole Sections

B. California State Department of Transportation (Caltrans) Standard Plans:

1. ES-8 Electrical Systems - Pull Box

C. California Public Utilities Commission (CPUC) General Orders (G.O.):

1. 128 Rules for Construction of Underground Electric Supply and Communication Systems

D. National Fire Protection Association (NFPA):

1. 70 National Electrical Code (NEC)

1.03 SUBMITTALS

A. Refer to Section 16000, Basic Electrical Requirements, for additional submittals and submittal requirements.

B. Submit manufacturer's product data for supports, covers, grounding, pullboxes and handholes, joint sealing compound, and other materials. Include concrete mix design.

C. Submit shop drawings for fabrication and installation of concrete structures.

D. Submit precast manufacturer's Certification of Compliance.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with NEC and PUC GO No. 128.

PART 2 – PRODUCTS

2.01 PRECAST CONCRETE HANDHOLES

A. Unless otherwise indicated, precast concrete handholes shall conform to Caltrans Standard Plan ES-8, No. 3-1/2T, No. 5T, and No. 6T, for H-20 loading, and AASHTO M199.

B. Pullbox No. 3-1/2T shall be "Christy" B1017 or Engineer approved equal, with minimum inside dimensions of 10-5/8 inch wide x 17-1/4 inch long x 24 inches deep. Pullbox shall be provided with bolt down checkered steel lid identified as "ELECTRICAL" or "COMMUNICATIONS", as required.

C. Pullbox No. 5T shall be "Christy" B1324 or Engineer approved equal, with minimum inside dimensions of 13-1/4 inch wide x 24 inch long x 24 inches deep. Pullbox shall be provided with bolt down checkered steel lid identified as "ELECTRICAL" or "COMMUNICATIONS", as required.

D. Pullbox No. 6T shall be "Christy" B1730 or Engineer approved equal, with minimum inside dimensions of 17 inch wide x 30 inch long x 24 inches deep. Pullbox shall be provided with bolt down checkered steel lid identified as "ELECTRICAL" or "COMMUNICATIONS", as required.

E. Where indicated on the Plans provide pullbox "Christy" B2436 or Engineer approved equal, with minimum inside dimensions of 24 inch wide x 36 inch long x 24 inches deep. Pullbox shall be provided with two (2) piece bolt down checkered steel lids, with one of the leads identified as "ELECTRICAL" or "COMMUNICATIONS", as required.

F. Where indicated on the Plans provide pullbox "Christy" B3048 or Engineer approved equal, with minimum inside dimensions of 30-1/4 inch wide x 48-1/4 inch long x 24 inches deep. Pullbox shall be provided with three (3) piece bolt down checkered steel lids, with center lid identified as "ELECTRICAL" or "COMMUNICATIONS", as required.

PART 3 – EXECUTION

3.01 CONCRETE HANDHOLES

A. Install handholes flush with concrete platform surface, or flush with sidewalks, curbs, paved areas and other concrete surfaces. Install top of handholes 2 inches above grade in landscaped areas. Seal unused openings with mortar.

B. Install no more than equivalent of three 90 degree bends between pull points.

C. Plug all ends of unused ducts and conduits in handholes. Use plugs manufactured for the purpose.

3.02 HANDHOLE INSTALLATION

A. Excavation and backfill shall be in accordance with Section 02300, Earthwork.

B. Install handhole structures in accordance with the requirements established for precast concrete drainage structures as specified under Section 02630, Storm Drainage System.

C. Set precast handholes on well-compacted soil with minimum of six inches of crushed stone base. Where duct lines enter handholes, sections of duct may be cast in concrete or may enter through square or rectangular opening of suitable dimensions.

D. Review location of handholes and obtain the Engineer's acceptance before installation of handhole is started.

E. Unless otherwise indicated, install ground rod at each pullbox. Provide all required accessories for grounding the pullbox cover(s) to the ground rod.

3.03 FIELD QUALITY CONTROL

A. Notify the Engineer for inspection and obtain Engineer's acceptance of handholes and pull boxes prior to installation of cable and equipment. Make corrections required.

END OF SECTION

SECTION 16250
WIRING DEVICES

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes requirements for line voltage wiring devices.

1.02 REFERENCE STANDARDS

A. National Electric Manufacturers Association (NEMA):

1.	WD 1	General Color Requirements for Wiring Devices
2.	WD 6	Wiring Devices – Dimensional Specifications

B. National Fire Protection Association (NFPA):

1.	70	National Electrical Code (NEC)

C. UL Solutions (UL):

1.	20	General-Use Snap Switches
2.	50	Enclosures for Electrical Equipment, Non-Environmental Considerations
3.	94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
4.	486A-486B	Wire Connectors
5.	498	Standard for Attachment Plugs and Receptacles
6.	514A	Metallic Outlet Boxes
7.	514B	Conduit, Tubing, and Cable Fittings
8.	943	Ground-Fault Circuit-Interrupters

1.03 SUBMITTALS

A. Refer to Section 16000, Basic Electrical Requirements, for additional submittals and submittal requirements.

B. Submit shop drawings.

C. Submit manufacturer product data for all types of wiring devices to be used.

PART 2 – PRODUCTS

2.01 DEVICES

A. Provide wiring devices conforming to the following UL Standards: 20, 50, 94, 486A-486B, 498, 514A, 514B and 943. Wiring devices shall also conform to NEMA WD 1 and WD 6.

B. Provide wiring devices indicated. Provide all similar devices of same manufacturer. Provide devices and device plates of the color and finish specified in the Contract Documents.

2.02 SWITCHES, FLUSH TUMBLER TYPE

A. General Requirements:

1. Unless otherwise specified or shown, use quiet type switches with ivory handles, rated 120/277 Volts ac and conforming to NEMA WD 1. Wiring methods shall be as specified in Section 16100, Wiring Methods.

2. Do not load switches more than 80 percent of their current rating.

3. Equip switches with metal mounting yoke with plaster ears, insulated from mechanism and fastened to switch body using bolts, screws, rivets or other substantial means to meet test requirements.

4. Provide green-colored equipment grounding screw on yoke. Switches shall be back or side wired with terminals of screw or combination screw-clamp type. Terminal screws shall be No. 8 or larger, captive or terminal type with access hole for back wiring. Wiring terminals shall be able to receive and hold proper wire size.

B. Standard Type Switches:

1. Tumbler type, totally enclosed, heavy duty. Catalog numbers listed below are for 120/277 Volt, 20 Amps, with ivory handles. Provide different color if specified in the Contract Documents. Where required, furnish 2 pole, 3 way and 4 way switches, and lock switches of comparable grade. Provide one key for each lock switch.

	SPST	DPST	3-WAY	SPST-KEY	4-WAY
Arrow-Hart	1991-I	1992-I	1993-I	1991-L	1994-I
Bryant	4901-I	4902-I	4903-I	4901-L	4904-I
Hubbell	1221-I	1222-I	1223-I	1221-L	1224-I
P & S	20AC1-I	20AC2-I	20AC3-I	20AC1-L	20AC4-I

or Engineer approved equal.

C. Weatherproof Switches:

1. Provide switch in cast metal box: Appleton or Crouse-Hinds Type FS or FD, or Engineer approved equal.

2. Cover and gasket: Appleton #FSK-1V, Crouse-Hinds #DS-181, or Engineer approved equal combination.

2.03 RECEPTACLES

A. Power receptacles and switches for general purpose circuits shall be manufactured per NEMA Specifications, rated as follows:

1. General purpose receptacles: NEMA 5-15R or 5-20R

2. Dedicated Receptacles: NEMA 5-20R

B. Receptacle bodies and bases: Fire resistant non-absorptive hot molded phenolic composition material or approved equivalent with metal plaster ears integral with supporting member.

C. Provide receptacles with light colored terminal facilities for neutral connections, amber or brass colored for phase conductor connections and green colored hexagonal machine screws for equipment grounding conductor and connections.

D. Receptacle contacts including grounding contact: Double grip bronze type with spring steel backup clips to ensure both sides of each male prong of plug will be in firm contact.

E. Provide receptacles with self-grounding clip or mounting strap green screws.

F. Ground fault circuit interrupter duplex receptacles: 120 Volt, 60Hz, 20 ampere with built-in test, reset buttons. Interrupt circuit within 1/30 second on a five milliampere earth leakage current. Maximum circuit capacity 20 amperes. Straight blade, heavy duty, industrial specification grade.

G. Ground Fault Circuit Interrupter Duplex Outlet (GFI): 20 amp, 125 Volt ac, 3 wire, grounding type, straight blade. Ivory color: Hubbell # GF5362IA, Pass & Seymour # 2095-SI, Leviton #7899-SGI, or Engineer approved equal.

H. Weatherproof Metallic Covers for Duplex GFI Receptacles: WPO listed, covers with this listing shall meet NFPA 70, Section 406.8(A) and 406.8(B) as applicable, and UL 514A receptacle requirements for wet location that is rated for wet location for either cover closed and/or cover open with device in use ("open"):

1. Surface Mounted: Appleton or Crouse-Hinds Type FS or FD cast box or equal with rated for wet location metal cover with gasket:

a. Appleton cover type FSK, Hubbell HBL5206WO, or Engineer approved equal

2.04 DEVICE COVER PLATES

A. Interior plates: Vandal resistant, stainless steel 14 gauge.

B. Exterior plates: Device cover plates shall be cast aluminum with self–closing hinged cover, rated for damp location.

C. Gang Plates: Use gang type plates for multiple units.

D. Screws: Vandal resistant stainless steel.

PART 3 – EXECUTION

3.01 GENERAL REQUIREMENTS

A. Install all wiring devices indicated complete with cover plates. Cover plates shall fit snugly against finished surfaces and line-up true with adjacent building lines, and be symmetrical in location and appearance.

B. Unless otherwise noted on the Contract Drawings, receptacles shall be installed in the vertical position with the grounding pin down.

END OF SECTION

SECTION 16450

PANELBOARDS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for panelboards providing fault interrupting capability and overcurrent protective devices.

1.02 REFERENCE STANDARDS

A. California Code of Regulations (CCR):

1. Title 24, Part 3, California Electrical Code

B. National Electrical Manufacturers Association (NEMA):

1.	AB 4	Guidelines for Inspection and Preventative Maintenance of Molded-Case Circuit Breakers Used in Commercial and Industrial Applications
2.	PB 1.1	General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 1000V or Less
3.	PB 1	Panelboards
4.	250	Enclosures for Electrical Equipment (1,000 Volts Maximum)

C. International Electrical Testing Association (NETA):

1.	ATS	Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

D. National Fire Protection Association (NFPA):

1.	70	National Electrical Code (NEC)

E. UL Solutions (UL):

1.	50	Enclosures for Electrical Equipment, Non-Environmental Considerations
2.	67	Panelboards
3.	486A-486B	Wire Connectors
4.	489	Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
5.	943	Ground-Fault Circuit-Interrupters

1.03 SUBMITTALS

A. Refer to Section 16000, Basic Electrical Requirements, for additional submittals and submittal requirements.

B. Product Data: Submit for each type of panelboard, overcurrent protective device, transient voltage surge suppressor (TVSS) device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

C. Shop Drawings: Submit for each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.

b. Bus configuration, current, and voltage ratings.

c. Short-circuit current rating of panelboards and overcurrent protective devices.

d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.

D. Qualification Data: Submit data for testing agencies indicating that they comply with qualifications specified under Quality Assurance herein.

E. Test Procedure for Overcurrent Protective Devices: Test procedures shall comply with NEMA AB-4 guidelines.

F. Field Test Reports: Submit written test reports and include the following:

1. Test procedures used

2. Test results that comply with requirements

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements

G. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

H. Maintenance Data: Submit operations and maintenance manuals for panelboards and components as specified in Section 01700, Contract Closeout.

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.04 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

1.05 MAINTENANCE MATERIALS

A. Keys: Furnish six spare keys of each type of panelboard cabinet lock.

B. Accessory Set: Furnish tools and miscellaneous items required for test, inspection, maintenance, and operation.

PART 2 - PRODUCTS

2.01 GENERAL

A. Panelboards shall comply with UL 67 requirements.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed.

B. Panelboards, Overcurrent Protective Devices, and Accessories:

1. Eaton Corp.; Cutler-Hammer Products

2. General Electric Co.; Electrical Distribution & Control Division

3. Siemens Energy & Automation, Inc.

4. Square D Company

5. Or Engineer approved equal

2.03 FABRICATION AND FEATURES

A. Enclosures: Surface-mounted cabinets. NEMA PB 1, Type 1, to meet environmental conditions at installed location.

B. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

C. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

D. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

E. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.

F. Bus: Hard-drawn copper, 98 percent conductivity.

G. Main and Neutral Lugs: Mechanical type suitable for use with conductor material.

H. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

I. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.

J. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

K. Skirt for Surface-Mounted Panelboards: Same gauge and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

L. Main overcurrent protective device: circuit breaker.

M. Branch overcurrent protective devices: bolt-on circuit breakers.

N. Door: hinged door over all circuit breaker handles. Doors shall have a semi-flush cylinder lock and catch assembly. Door-in-door trim shall be provided. Both hinged trim and trim door shall utilize three point latching.

2.04 PANELBOARD SHORT-CIRCUIT RATING

A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.05 OVERCURRENT PROTECTIVE DEVICES

A. General: Devices shall be the latest approved design as manufactured by a nationally recognized manufacturer and in conformity with applicable standards and listings of nationally recognized testing laboratories. Devices shall comply with UL standards 489, 50, 67 and 943.

1. Overcurrent protective devices shall be molded-case circuit breakers as specified herein.

B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

C. Breakers shall be bolt-on type suitable for individual as well as panelboard mounting. Breakers shall be bolt-on type, no "plug-on" type panelboard breakers allowed.

D. Breakers shall meet current National Electrical Manufacturers Association (NEMA) and Underwriters Laboratories (UL) specifications as applicable to frame size, standard rating, and interrupting capability.

E. Breakers shall be one, two, or three pole as scheduled, and shall be of the quick-make, quick-break thermal magnetic type. They shall be trip free to prevent closing when a fault exists. The handle positions shall clearly indicate "ON", "OFF", and "TRIPPED" positions. Two pole breakers shall be physically the same size as two single-pole breakers, thereby permitting any combination of one, two, or three pole breakers.

F. Operating handle shall open and close all poles simultaneously on a multi-pole breaker.

G. Provide Class A (5ma sensitivity) breakers where GFI Type breakers are required.

H. Breaker Features and Accessories. Standard frame sizes, trip ratings, and number of poles.

I. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.

J. Size overcurrent protective devices as shown on the panel schedule in the Contract Documents or as required by the load being served. Provide separate neutral conductors for circuits protected by GFI breakers.

2.06 FEATURES

A. Fungus Proofing: Permanent fungicidal treatment for panelboard interior, including overcurrent protective devices and other components.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Comply with mounting and anchoring requirements for seismic zone 4 location.

C. Mounting Heights: Top of trim 74 inches above finished floor, unless otherwise indicated.

D. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

E. Circuit Directory: Refer to Section 16000, Basic Electrical Requirements. Create a directory to indicate installed circuit loads after balancing panelboard loads.

F. Install filler plates in unused spaces.

G. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.02 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 16000, Basic Electrical Requirements.

3.03 CONNECTIONS

A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.04 FIELD QUALITY CONTROL

A. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

B. Balancing Loads: When all loads are connected, measure load balancing and make circuit changes as follows:

1. Measure as directed during period of normal system loading.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data-processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.

4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

C. Infrared Scanning: When all loads are connected, perform an infrared scan of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.06 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 16800
SITE LIGHTING

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes requirements for site lighting system, including lighting control and protection components.

1.02 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1. Structural Supports for Highway Signs, Luminaires, and Traffic Signals

B. American National Standards Institute (ANSI):

1.	C136.2	Roadway and Area Lighting – Dielectric Withstand and Electrical Transient
2.	C136.31	Roadway and Area Lighting – Luminaire Vibration
3.	LM-80	Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules
4.	TM-21	Technical Memorandum: Projecting Long-Term Luminous Flux, Photon, and Radiant Flux Maintenance of LED Light Sources

C. Institute of Electrical and Electronics Engineers (IEEE):

1.	C2	National Electrical Safety Code (NESC)

D. National Fire Protection Association (NFPA):

1.	70	National Electrical Code (NEC)

E. UL Solutions (UL):

1.	1598	Luminaires
2.	8750	Light Emitting Diode (LED) Equipment for Use in Lighting Products

1.03 SUBMITTALS

A. Refer to Section 16000, Basic Electrical Requirements, for additional submittals and submittal requirements.

B. Submit shop drawings including dimensions and components for each luminaire which is not a standard product of the manufacturer. Submit shop drawings of

the lighting control cabinet, including layout drawing, control schematic, and wiring diagram.

C. Submit product data including dimensions, ratings, and performance data.

D. Submit test reports indicating measured illumination levels.

E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency.

F. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

G. Maintenance Data: Submit maintenance data including instructions for maintaining luminaires.

1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of NEC.

B. Furnish products listed and classified by a nationally recognized testing laboratory.

PART 2 – PRODUCTS

2.01 LIGHTING FIXTURES - GENERAL

A. Refer to Contract Drawings for Lighting Fixture Schedule.

B. All lighting fixtures shall have polycarbonate lenses. All fixtures shall have a minimum IP rating of 65.

C. The exterior lighting fixtures for the temporary station platforms shall be LED as indicated on the Contract Drawings. Fixture voltage shall be selected to coordinate with the existing source available.

D. Luminaires shall comply with UL 1598. LED drivers shall conform to FCC Title 47, Part 15 and shall provide for 0-10V dimming where required by the Contract Drawings.

E. The finish of exterior luminaires shall be corrosion resistant, electrostatically applied on painted components.

F. All LED drivers shall include surge protection. Where applicable, drivers shall conform to the "Enhanced" level (10 kV/5 kA) of ANSI C136.2.

G. Fixtures shall be listed by a nationally recognized testing laboratory for wet locations.

H. Gaskets shall be high quality, high temperature gaskets providing positive weatherproof seals.

I. Furnish mounting hardware and appurtenances with each fixture.

J. Luminaires shall have a minimum L70 lumen maintenance value per ANSI/IES TM-21 of 50,000 hours (min.) unless noted otherwise. Luminaire drive current must be identical to that provided by test data for the luminaire in question.

2.02 FIXTURE MOUNTING HARDWARE

A. Lighting fixtures shall be designed with mounting brackets to provide the nominal mounting heights of luminaires as indicated on the Contract Drawings.

B. Arms, mounting brackets, lighting poles, bases, and all hardware shall be coordinated with the lighting fixtures to provide a complete installation. All shall be compatible in appearance, finish, and assembly.

C. Lighting poles shall be designed and fabricated according to AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals. Light poles shall be designed for 90 mph wind velocity and shall take into account attachments such as CCTV cameras and PA speakers. Poles installed on bridge structures shall have a 3G rating in accordance with ANSI C136.31.

D. Where applicable, lighting poles shall be provided with grounding lugs capable of accepting a #2 AWG tap from the OCS (Overhead Catenary System) system counterpoise ground. This shall be in addition to the ground lug provided for connection to the equipment grounding conductor and supplementary ground.

E. Mounting brackets for temporary station platform lights shall be suitable for wood pole mounting, fabricated from standard pipes, with an insulated wire inlet and rod to secure arm to wood pole. Wood pole shall be ANSI Class 5, of the length indicated on the Contract Drawings.

2.03 LIGHTING CONTROL EQUIPMENT

A. Lighting control cabinet shall be NEMA Type 12 for indoor installation and NEMA Type 4 for outdoor installation. Cabinets shall be designed for wall mounting or shall be self-standing, with dimensions as indicated on the Contract Drawings. Outdoor cabinets shall have outer and inner doors, backpanel, and hasp for padlocking.

1. Time Switches: Digital type, two channels, with 365 days advance single holiday and seasonal schedule. Time switch clock input shall be 120 volts, 60 hertz, and shall be provided with two DPDT contacts rated a minimum of 10 amperes continuous duty. Time switch shall be able to retain the schedule for 40 years without power.

2. Photoelectric Unit: Furnish photoelectric unit and necessary hardware suitable for mounting where required on the Drawings.

3. Selector switch: Selector switch shall be NEMA 4X, oiltight/watertight, with contact block arrangement as required on the Contract Drawings.

4. Lightning arrestor: Lightning arrestor shall be a secondary surge arrestor for electrical wiring.

5. Terminal blocks: Terminal blocks shall be provided for all incoming and outgoing circuits. Terminal blocks shall be rated 600 volts, and shall be UL listed. Terminal blocks for incoming circuits shall be suitable for wire sizes ranging from #20 AWG to #6 AWG. Terminal blocks for outgoing circuits shall be suitable for wiring ranging from #8 AWG to #4 AWG.

6. Wire management: Plastic wire duct with slotted sidewall and with cover, sized as indicated on the Contract Drawings or as required.

B. Control equipment shall provide components and connections which will allow automatic control of the lighting system. The controls shall provide on-off control of the lighting in response to two modes of operation:

1. Manual

2. Automatic: In the automatic mode, the primary control device shall be the photocell unit. The time clock shall be wired into the control circuit such that certain lights may be turned off or dimmed for a preset period of time during the normal photocell on period. The time clock controlled off operation shall be completely programmable for periods of time as short as 15 minutes and the setting shall be visible on the face of the time clock.

C. Control shall be provided by a relay panel based system. All components required for a complete and functioning system are the responsibility of the relay system manufacturer. Acceptable manufacturers are Leviton, Watt Stopper, Cooper Lighting, Hubbell, or equal.

1. Relay Panels

a. Provide a number of relays as required to control circuits indicated on the Contract Drawings.

b. Provide a barrier to separate low and high voltage compartments.

c. Panel controller power supply: unit shall provide a single transformer with single primary fusing; capable of 120V or 277V +/- 10 percent primary power. Provide a grounding stud in the high voltage compartment.

2. Relays

a. Each controlled circuit shall be connected through a single pole, single throw momentary-pulsed mechanically latching contactor rated at 20 amps, 120-277 VAC.

b. Relays shall be zero-crossing, capable of withstanding high inrush currents. Warranty relays for use with LED drivers.

c. Relay shall be:

1) Mechanically latching relay using a dual coil technology.

2) Relays shall attach to the barrier and plug into the relay interface board via quick connect plug in connectors.

3) All relays shall be factory wired for low voltage control; field wiring or field rewiring is not acceptable.

D. Relay system performance

1. Relay operation shall be sequenced to reduce the inrush effects on the power system.

2. Commanded load feedback: Unit shall provide feedback of the commanded state of each relay.

3. Selectable Output Energize Time: Unit shall provide selectable energize duration from 0.024 to 1.56 seconds. All circuits shall not be turned on or off simultaneously, but staged on and off to prevent line surges.

4. System shall be capable of manual overrides.

5. Output Refresh Rate: Unit shall provide the capability to send commands to its outputs to assure proper status based on a user selectable rate of every 3-30 minutes.

6. Selectable Switch Inputs: Unit shall provide maintained, momentary on, momentary off, momentary on/off and linked switch inputs with selectable switch input timers of up to 18 hours. The minimum number of switch inputs for each lighting relay panel shall equal the number of relays.

7. Selectable Switch Input Polarity: Unit shall provide for normally open or normally closed switch inputs. Isolated RS-485 serial communications port.

8. Local programming: All features shall be selectable at the unit and from a remote PC terminal.

9. Local status LEDs: Unit shall provide separate status LEDs for each relay.

10. Filtering: Provide filters to reduce noise emissions and power line spikes.

E. Software and Network

1. Relay groupings: software shall provide selectable grouping of relays that can be operated from the same control signals.

2. Any control device shall be assignable to any lighting relay or relay group via software without the need for rewiring.

3. Memory loss protection: Provide non-volatile memory so data is not lost during power outages.

4. EPROM and EEPROM Diagnostics: Unit shall have the software capability to run a diagnostic check of the unity's EPROM (Electrically Programmable Read Only Memory) and EEPROM (Electrically Erasable Programmable Read Only Memory) at any time. If the panel detects any problem with its memory after power-up, a warning LED shall flash to indicate a problem exists.

PART 3 – EXECUTION

3.01 GENERAL

A. Provide grounding to fixtures in accordance with Section 16060, Grounding and Bonding. Wiring methods and devices shall be in accordance with Sections 16100, Wiring Methods, and 16250, Wiring Devices. Handholes and pull boxes for running wiring to the luminaires and posts shall be in accordance with Section 16140, Concrete Handholes and Pull Boxes.

3.02 LIGHTING FIXTURES

A. Install in accordance with manufacturers' instructions.

B. Install lighting poles at locations indicated on the Contract Drawings. Locations on Contract Drawings are diagrammatic. Obtain Engineer's approval of exact locations in field.

C. Bond luminaire, metal accessories, and metal poles to branch circuit equipment grounding conductor. Provide supplementary grounding electrode in the adjacent handhole or at the pole base where indicated on the Contract Drawings. Provide additional bonding to the OCS system counterpoise ground where indicated on the Contract Drawings. Refer to Section 16060, Grounding and Bonding.

D. Avoid interference with and provide clearance for equipment. Where the indicated locations for the lighting fixtures conflict with the locations for equipment, change the locations for the lighting fixtures by a minimum distance necessary as approved by the Engineer. For purposes of this Section, clearances and interferences will be as defined in the NESC.

E. Photoelectric controls shall provide control to the lighting contactors for the lighting systems and shall be powered independent of the wiring to the luminaire.

3.03 LIGHTING CONTROL DEVICES

A. Apply labels or stencil to control components to identify components and their purpose.

B. Lightning Arrestor: Install lightning arrestor within the control cabinet.

C. The lighting control system manufacturer shall provide a factory trained technician to verify and program setpoints for each photocell, switching device, and time clock.

3.04 FIELD QUALITY CONTROL

A. Take light meter readings in the presence of the Engineer at night to ensure proper lighting levels of all lighting systems. Provide the labor and equipment to make any required adjustments at this time. Notify the Engineer at least 48 hours prior to performing this test. This test shall be accomplished in the presence of the Engineer. Submit the test results to the Engineer in writing prior to Final Inspection.

B. After completion of the work, place illumination system in operation. Final acceptance will not be made until the system has operated satisfactorily for a period of not less than 30 days from the date designated by the Engineer. This test period shall be included with the specified Contract time. Operation of the system shall not in any way be construed as an acceptance of the system or any part of it or as a waiver of any of the provisions of the Contract. The Contractor shall be responsible for the system during this period of operation and shall make any adjustments or repairs which may be required and remedy defects or damage which may occur.

END OF SECTION

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 Division 17, Station Communications, except as otherwise specified. This and all other Specification Sections are collectively referred to Specifications.

1.03 REFERENCE STANDARDS

A. Military Standard (MIL-STD):

1. 1472 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. 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. Coordination and performance of work of all trades

    i. 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 can 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 / Duct-bank Subsystem

   d. Communications Cable

   e. Power Cable

   f. Fiber Optics Cable Subsystem

   g. Public Address (PA) Subsystem

   h. Visual Message Sign (VMS) Subsystem

   i. CCTV (Security Cameras)

   j. Ticket Vending Machines (TVMs)

   k. Clipper Network Card Interface Devices (CIDs)

   l. Train Information Display Signs (TIDS)

   m. Station Network Subsystem

   n. Power Supplies and Distribution

   o. Grounding and Protection

p. Miscellaneous Items

2. Each Preliminary Design package shall be organized to include the following headings and information:

   a. Preliminary Design Package Purpose and Scope: A brief description and introduction of the package.

   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 communications interfaces. 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, Alarm Points and any other required interfaces with CCF, BCCF and Caltrain Headquarters.

      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 or exceeds the operational, functional, and performance required by the Contract Documents. The models to be used in the contract shall be explicitly identified in the product data sheet. The product shall have a life span of not less than 5 years and shall have manufacturer's support available for 10 years after the product has reached its end of life. In addition to data sheets, provide manufacturer's information pertaining to product life span and availability of support for review and approval by the Engineer.

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, wiring, and functional diagrams with corresponding parts list, conduit and cable schedule, equipment installation and grounding details.

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:

1) Corresponding subsystem design review drawings with updates and details. Include detailed physical layout drawings with material list keyed to the layouts.

2) 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 by the corresponding voltage drop, cable gauge and conduit fill calculations, which shall be approved by the Engineer.

3) Cable and wiring connectors and terminal assignments.

4) Wiring diagrams to include terminal blocks, power panel details, Local Distribution Frames (LDF), Main Distribution Frame (MDF), wire and cable identifications, connector types, and any additional wiring required for a complete design.

5) Nameplate and labeling schedule for all equipment including every wire, cable, connector, terminal and rack.

6) Electrical power diagrams and panel and power strip schedules.

7) Mounting, securing, seismic protection and installation details for all equipment and materials.

8) For racks in which equipment will be installed, rack-face elevations with all intra-rack and inter-rack wiring and cabling to be installed.

9) Power connections, panel schedules and grounding/protection connections.

10) Location of all safety and hazard warning signs and labels.

11) 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:

1) Factory Testing

2) Inspection

3) Field Equipment and Subsystem Testing

4) End-to-End Acceptance Test

5) System Integration Test

d. The test program shall include a list of 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:

1) Type of test

2) Tools and Test Equipment

3) Prerequisites

4) Pass and fail criteria

5) Personnel and laboratory requirements

6) Required Cutover and Phasing: The cutover sequences shall be accompanied with the corresponding fallback procedures (should something go wrong).

7) Expected Impacts (Outages, Operational, Environmental, and Traffic, Revenue) and recovery Plan when required.

8) Engineer's resources

9) Scheduled date and expected duration

10) 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 of 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 and test equipment: List test equipment and tools, with calibration data for each item. Test devices must be calibrated and certified by an accredited calibration laboratory. Calibration certificate shall include a list of calibration standards or statement of traceability, calibration date, and other applicable information to ensure the device was calibrated correctly.

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 a 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 meet the system design and performance requirements outlined in the Specifications.

e. Completed Test and Inspection Records: A completed, signed, and dated test/inspection procedure sheet, 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

A. Refer to individual Specification Sections for products.

2.01 SPARE PARTS

A. Refer to individual Specification Sections for spare parts.

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. 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:

a. Comply with MIL-STD-1472.

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.

D. Continued Operation of Rail System

1. The Caltrain Rail System conducts Revenue Operations seven days a week. The existing Communications systems and the Central Control Facility (CCF), Backup Central Control Facility (BCCF) and the Headquarters 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, BCCF, Headquarters and Fare Collection system.

3. During revenue or non-revenue hours, any disruption to the existing Communications systems, CCF, BCCF and the Headquarters shall be minimized. To the extent possible, no more than a single node shall be unavailable through the existing Communications systems and CCF, BCCF or the Headquarters at any point in time without prior approval from the Engineer.

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.

E. 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.

F. 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:

      1) Engineer approved drawings and other design documentation

      2) Subsystem or Component Parts List

      3) Manufacturing and Quality Assurance Inspection Records

      4) Test Plan and Procedures

      5) Tools and staff to make measurements

6) 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 installation.

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, 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:

      1) Electrical Interface

      2) Functional Interface

      3) 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:

      1) Electrical Interface

2) Functional Interface

3) Mechanical Interface

4) 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

f. Proper local and remote operation of Train Information Display Signs.

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. 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). The 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 the 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):

1. C2 National Electrical Safety Code

B. ASTM International (ASTM):

1. A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

2. A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

3. B3 Standard Specification for Soft or Annealed Copper Wire

4. E84 Standard Test Method for Surface Burning Characteristics of Building Materials

5. F512 Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation

6. F593 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

C. Electronic Components Industry Association (EIA/ECA):

1. 310 Cabinets, Racks, Panels, and Associated Equipment

D. California Building Code (CBC)

E. California Electrical Code (CEC)

F. International Building Code (IBC)

G. National Electrical Contractors Association (NECA):

1.	1	Standards for Good Workmanship in Electrical Construction

H. National Fire Protection Association (NFPA):

1.	70	National Electrical Code (NEC)
2.	130	Standard for 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-Treated Wood and Fire-Retardant Coatings for Building Materials

I. National Electrical Manufacturers Association (NEMA):

1.	250	Enclosures for Electrical Equipment (1000 Volts Maximum)
2.	ICS 1	Industrial Control and Systems: General Requirements
3.	ICS 4	Application Guideline for Terminal Blocks
4.	ICS 6	Industrial Control and Systems: Enclosures
5.	FB 1	Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing (EMT), and Cable
6.	IM 60000	Industrial Laminating Thermosetting Products
7.	VE 1	Metal Cable Tray Systems
8.	WC 70	Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
9.	WD 1	General Color Requirements for Wiring Devices

J. Telecommunications Industry Association (TIA):

1.	568	Commercial Building Telecommunications Cabling Standard
2.	606	Administration Standard for Telecommunications Infrastructure
3.	607	Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

K. State of California Public Utilities Commission (CPUC):

1.	G.O. 128	Rules for Construction of Underground Electric Supply and Communication Systems

L. UL Solutions (UL):

1.	5	Standard for Surface Metal Raceways and Fittings
2.	6	Electrical Rigid Metal Conduit – Steel
3.	50	Enclosures for Electrical Equipment, Non-Environmental Considerations
4.	50E	Enclosures for Electrical Equipment, Environmental Considerations
5.	94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
6.	497	Standard for Protectors for Paired-Conductor Communications Circuits
7.	508	Standard for Industrial Control Equipment
8.	514A	Metallic Outlet Boxes
9.	514B	Conduit, Tubing and Cable Fittings
10.	651	Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings
11.	651A	High Density Polyethylene (HDPE) Conduit
12.	969	Standard for Marking and Labeling Systems
13.	1059	Standard for Terminal Blocks

1.04 SUBMITTALS

A. Submit Installation Work Plan including the following items:

1. Equipment layout, plan and elevation views

2. Conduit and raceway installation plan between pull boxes and manholes, and from communications cabinets, Communications Equipment Room (CER) and communications devices to pull boxes and/or manholes. Also installation of cable trays in CER.

3. Wire and cable installation work plan and procedures.

4. Wiring diagrams between station devices and communications equipment, and from CER to DC including all tagging identifiers

5. Conduit and conductor schedule showing conduit fill percentages per NEC.

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 Codes:

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 as specified in Section 17000 Basic Communications Technical Requirements.

4. All grounding shall be in accordance with NEC standards, TIA/EIA 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-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-606. Software shall be able to properly operate on Windows 10, or latest revision of, Windows 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:

        1) HIL represents originating location "from" (Hillsdale)

        2) CER represents originating facility type (Communications Equipment Room)

        3) FDP represents originating termination cabinet/panel (Fiber Distribution Panel)

        4) / represents "to"

        5) BAS represents ending location (Bayshore)

        6) CER represents ending facility type (Communications Equipment Room)

        7) FDP represents ending termination cabinet/panel

        8) FS12 represents cable type (Fiber Single-mode 12 strand)

        9) 01 represents cable number (01-99)

b. Sample tag Scheme for Station Distribution Cable: HIL-CER-FDP / DC1-FS02-01; with:

1) HIL represents Location "from"

2) CER represents facility type

3) FDP represents originating cabinet/panel

4) / represents "to"

5) DC1 represents ending distribution cabinet, panel, or equipment

6) FS02 represents cable type (Fiber Single-mode 2 strand)

7) 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:

1) FS01 represents cable type (Fiber Single-mode 1 strand patch cord)

2) 01 represents cable number (01-99)

3) FDP represents originating cabinet/panel

4) SL4-14 represents originating demarcation panel/card slot and port number

5) / represents "to"

6) RTU represents ending cabinet, panel, or equipment

7) 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:

1) HIL represents originating location area (Hillsdale)

2) CER represents originating facility type

3) / represents "to"

4) BAS represents ending location area (Bayshore)

5) CER represents ending facility type

6) PCO represents Pathway, such as "conduit"

7) 01 represents conduit one (01-99)

8) 3 inch represents 3 inch diameter conduit

e. Sample tag Scheme for Internal Conduits, CER-FDP / PB01-PCO-01-0.75; with:

1) CER represents originating facility type "from"

2) FDP represents originating cabinet/panel

3) / represents "to"

4) PB01 represents ending pull-box, cabinet or equipment

5) PCO represents Pathway, such as "conduit"

6) 01 represents conduit one (01-99)

7) 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 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 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 or MPOE 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.

a. Fire Retardant Paint for Backboard: Paint shall comply with the requirements of ASTM E 84 (NFPA-255) and matching Federal Standard FS-595b, Color No. 27925, (Reference NFPA -255 and 703). Primer and paint shall be compatible with wood treatment.

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 6 50-pair connectorized punch-down blocks (as described in Articles entitled Punch-down Blocks herein) utilizing 25 pair connectors per Article entitled Twenty-Five Pair Connectors as cross-connects. (Mount on plywood backboard)

4. 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)

5. Single mode fiber optic patch panel to terminate the fiber optic drop cable from Caltrain-owned fiber optic cable plant.

6. Communication ground bus bar mounted on the plywood backboard.

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 6 inches

2. The width of the cable tray shall be a minimum of 6 inches.

3. Top and bottom flange section shall each be a minimum of 1 inches.

4. Flange width shall be approximately 0.75 inches.

5. Height of rail shall be a minimum of 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 of the design of one manufacturer as the cable tray and 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. The cable tray systems shall be designed so that there are no burs, projections, or sharp edges.

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 LI1.

L. The cable tray system shall be UL listed and classified for use as an equipment ground conductor. The cross sectional area of each straight section or fitting shall be marked on each side of the section or fitting.

M. Cable tray loading shall be in compliance with the latest NEMA VE 1 standards.

2.10 OUTDOOR EQUIPMENT CABINETS

A. Outdoor Main Distribution Frame: For station where a Communications Equipment Room (CER) or prefabricated house does not exist, an MDF shall be provided and shall consist of the following:

1. A floor mount NEMA 3R outdoor rated enclosure, 6 feet tall by 6 feet wide with two lockable doors, air condition unit shall be provided. This enclosure is referred to as Station Communications Cabinet (SCC) or Communications Interface Cabinet (CIC) and shall house the MDF, or MPOE and all required communications equipment for interfacing with the stations' Distribution Cabinets and subsystems as shown on Contract Drawings.

2. 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 shall be provided with terminals to terminate the number of pairs of the incoming cable, as shown on Contract Drawings.

3. 110 Type CAT 6, 50-pair connectorized punch-down blocks (as described in Articles entitled Punch-down Blocks herein) utilizing 25 pair connectors per Article entitled Twenty-Five Pair Connectors as cross-connects, as shown on Contract Drawings.

4. 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 back panel)

5. Single mode fiber optic patch panel to terminate the fiber optic drop cable from Caltrain-owned fiber optic plant and cables from station equipment and devices as shown on Contract drawings.

6. One duplex 120VDC UPS receptacle and back-box. Receptacles will be NEMA L5-30R (twist lock).

7. One duplex 120VDC general purpose receptacle and back-box.

8. Communications ground bas bar mounted on plywood back panel.

B. Floor mounted Distribution Cabinet (DC) shall be provided as described in the following paragraphs:

1. Outdoor equipment cabinets shall be NEMA type 3R, floor mounted encasing a 19 inch EIA aluminum equipment mounting rack. Cabinets shall have an overall height of 67 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.

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

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

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

5. 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).

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

7. Cabinets shall be equipped with UPS and general-purpose ac receptacles, ac power strips, ground bus bars, horizontal and vertical cable management, and other non-electronic type components as shown on the Contract Drawings.

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

9. Cabinets shall be equipped with louvered side panels, or ac unit sized as shown on Contract Drawings.

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

C. Wall mounted, pole mounted, ceiling mounted, and enclosures of mounting methods other than floor-mounted cabinets shall be referred to as Communications Cabinets and shall be provided as shown on Contract Drawings and as described in the following paragraphs:

1. The equipment cabinet shall be NEMA type 4X or NEMA type 3R. These communications cabinets shall be provided as required by the Contract Documents to satisfy the operational and functional requirements of the station's subsystems.

2. The cabinet shall be provided with back-panel, ground bus bar, and mounting hardware.

3. The cabinet shall be provided with communications equipment, terminal blocks, surge protection devices, and other hardware as shown on Contract Drawings.

4. Cabinet shall be provided with locking front door.

5. Obtain the approval of the Engineer for the cabinet and for the communications equipment.

6. The cabinet shall be powered by a UPS source from either the CER, SCC, CIC, or DC as shown on Contract Drawings.

7. The cabinet shall be provided with a minimum of two knockouts for conduit entry as shown on Contract Drawings. Power and Communications cables shall enter the cabinet through separate conduits.

8. Cabinet design, furnish, and installation shall also 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, or fans

   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 ECA-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 the 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 UPS and general-purpose AC receptacles, 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 side panels, or fans as shown on Contract Drawings.

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 Station Communications Cabinet (SCC) or Communications Interface Cabinet (CIC) shall be as shown on the 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 Buss-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.

G. Floor Mounted Outdoor Equipment Cabinets:

1. Outdoor equipment cabinet shall be installed on a concrete pad of 10" minimum depth. The top of the pad shall be 4" above ground level. The concrete pad shall extend a minimum of 3" from each side of a cabinet. Where AC unit is attached to one side of the cabinet the concrete pad shall be extended a minimum of 3" from the AC. Concrete pad shall have #4 AWG rebar spaced at 10" each way.

2. Conduits shall be bundled at back of concrete pad and shall be stubbed up 2" maximum.

3. Concrete pad shall have a 1" radius chamfer.

4. Outdoor Equipment Cabinets shall be grounded as specified in Section 17160.

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. 607 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

B. ASTM International (ASTM):

1. B187 Standard Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes

2. B3 Standard Specification for Soft or Annealed Copper Wire

3. B8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

4. C653 Standard Guide for Determination of the Thermal Resistance of Low-Density Blanket-Type Mineral Fiber Insulation

5. D5 Standard Test Method for Penetration of Bituminous Materials

6. D149 Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

7. D257 Standard Test Methods for DC Resistance or Conductance of Insulating Materials

8. D570 Standard Test Method for Water Absorption of Plastics

C. Institute of Electrical & Electronics Engineers (IEEE):

1. 81 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

2. 3003.1 Recommended Practice for System Grounding of Industrial and Commercial Power Systems

3. 3003.2 Recommended Practice for Equipment Grounding and Bonding in Industrial and Commercial Power Systems

D. Lightning Protection Institute (LPI):

1. 175 Standard for the Design-Installation–Inspection of Lightning Protection Systems

E. National Fire Protection Association (NFPA):

1. 70 National Electrical Code (NEC)

2. 130 Standard for Fixed Guideway Transit and Passenger Rail Systems

3. 780 Standard for the Installation of Lightning Protection Systems

F. National Electrical Safety Code (NESC)

G. California Electrical Code (CEC):

1. Title 24 Part 3

H. UL Solutions (UL):

1. 467 Grounding and Bonding Equipment

2. 1449 Surge Protection Devices

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 be 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 arrestor equipment

h. Grounding bus bars

i. Lightning rods

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 requirements.

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 shell 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 Communications Cabinets. 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 be 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 standards.

2.02 GROUND RODS

A. Ground rods shall be copper-bonded and shall have a high strength carbon steel core. The copper coating shall be 10 mils minimum thickness and shall not break when the rod is bent or driven in ground. The rod shall be at least 3/4 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. Ground Rod shall be Erico, 613400, 614400, or Engineer approved equal.

B. Ground rod clamps shall be UL listed, made of a cast bronze clamp body with non-ferrous setscrews and suitable for use with copper-bonded ground rods and for direct burial in earth or concrete as manufactured by Erico, 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 BUS BARS

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 ½ inch diameter by 2 inches length, threaded holes at both ends for MGB and CGB installation.

2.11 EPOXY RESIN ENCAPSULATION

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

2.12 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.

2.13 COMMUNICATIONS CIRCUIT PROTECTION

A. Related to copper cables that enter all Communications Facilities and Communications Cabinets. 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. 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 hand-holes, 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, 3/4 inch diameter. Install ground rods vertically if possible. Where vertical burial

is not possible, rods may be at a maximum angle of 45 degrees 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 southernmost 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. 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 HOUSING 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 568 Commercial Building Telecommunications Cabling Standard

2. TIA 607 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

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

1. Handbook - Fundamentals, Chapter 26

2. Publication SPCDX (Climate Data for Region X)

3. Guideline 16, Selecting Outdoor, Return, and Relief Dampers for Air-Side Economizer Systems

4. Standard 62.1, Ventilation for Acceptable Indoor Air Quality

C. ASTM International (ASTM):

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

2. B3 Standard Specification for Soft or Annealed Copper Wire

D. American Society of Civil Engineers (ASCE):

1. 7 Minimum Design Loads and Associated Criteria for Buildings and Other Structures

E. California Building Code (CBC)

F. California Electrical Code (CEC)

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

1. RP-7 Recommended Practice for Lighting Industrial Facilities

H. International Building Code (IBC)

I. Institute of Electrical and Electronics Engineers (IEEE):

1. 3003.1 Recommended Practice for System Grounding of Industrial and Commercial Power Systems

2. 3003.2 Recommended Practice for Equipment Grounding of Industrial and Commercial Power Systems

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 for Automatic Fire Detectors

3. 101 Life Safety Code

L. National Electrical Contractors Association (NECA):

1. 1 Standard for Good Workmanship in Electrical Construction

M. National Electrical Manufacturers Association (NEMA):

1. AB 1 Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures

2. CC 1 Electric Power Connection for Substations

3. PB1 Panelboards

4. FB 1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable

5. VE 1 Metal Cable Tray Systems

N. UL Solutions (UL):

1. 50 Enclosures for Electrical Equipment, Non-Environmental Considerations

2. 67 Standard for Panelboards

3. 467 Grounding and Bonding Equipment

4. 497 Standard for Protectors for Paired-Conductor Communications Circuits

5. 969 Standard for Marking and Labeling Systems

1.03 DEFINITIONS

A. "Communications Housing Facilities" shall mean conditioned and secured space required to house station communications equipment at stations. This space is commonly referred to as the Communications Equipment Room (CER). Communications equipment rooms are divided into two types, Type I and Type II as described herein these Specifications.

B. Type I CER: This CER shall be a prefabricated building, or a room specifically designated for communications equipment in a prefabricated building. It shall contain the MDF or MPOE and all the required network and subsystems communications equipment to serve the passenger station.

C. Type II CER: This CER shall be a room within a combined structure to be built or remodeled as an integral part of a station. It shall contain, the MDF or MPOE and all the required network and subsystems communications equipment to service the passenger station.

D. Communications Interface Cabinet (CIC), also sometimes referred to as Station Communications Cabinet (SCC) shall be used to house communications equipment and to provide all required interfaces between the station Distribution Cabinets and the Main Distribution Frame (MDF) or the Main Point of Entry (MPOE) where Type I or Type II CER cannot be provided at the station. This cabinet shall be provided as described in Section 17050 and as shown on Contract Documents.

1.04 SYSTEM DESCRIPTION

A. 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) or Main Point of Entry, (MPOE), 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, Type I and II shall be equipped with proper fire extinguishers and fire monitoring systems as described in these specifications.

E. Communication Facilities 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 or MPOE, 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 thermal 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.

7. Cable tray system shall be sized and installed as shown on Contract Drawings and approved submittals.

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 I 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 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 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 Buss-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. Calculations shall be signed and sealed by a licensed Professional Engineer.

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 duct bank, including the man-hole interface.

b. Site plans for the Communications Houses.

c. Installation Plan to include:

1) Planned access dates and times for each location

2) Safety rules, regulations and procedures

3) Caltrain resources required

4) Daily preparation and cleanup procedures

d. Delivery and Installation Procedures and Inspection Sheets:

1) The procedures submitted shall include descriptions of the equipment used for transport and setting of the Communications Facility.

2) 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. Final 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. Submit sample of address signage for Engineer approval.

3. 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 TIA-607.

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 I 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.

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. SDT 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 address signage on the outside 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 an electrical panel board of the voltage shown on the Contract Drawings rated according to the Engineer approved calculations. As a minimum, the electrical panel shall be 100 Amp panel board. A surge protective device meeting the requirements of NEC Article 242 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.

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. LED light fixtures, 24 inches in length, shall be provided as shown on the Contract Drawings.

   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 thermal 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 thermal 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 and shown on Contract Drawings.

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) or MPOE 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 shall be bonded to the MGB as required by the Specifications.

9. Cable trays shall be provided in accordance with the 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 and Contract Drawings.

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 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.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Cable Entrance Conduits:

1. Install four 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 and a cable ladder to route the cables as shown on Contract Drawings. 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 but not less than the minimum bending radius required by NEC and shall be as required by these Specifications and shown on Contract Drawings.

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.

B. Grounding:

1. Install, as a minimum, one ground rod outside each comer 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:

1) 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.

2) Should the Engineer decide that the installation drawings and procedures are inadequate, revise any such drawings and procedures prior to performing installation Work.

3) 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:

1) Conformance to installation requirements

2) Conformance to standards, methods and quality

3) Proper routing and termination of wire and cable

4) Secured cable and wire connections

5) Proper grounding of all equipment

6) 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 Standard for Optical Fiber Outside Plant Communications Cable

2. TIA-607 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

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

1. Manual for Railway Engineering

C. ASTM International (ASTM):

1. B3 Standard Specification for Soft or Annealed Copper Wire

2. D1248 Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable

3. D4101 Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials

4. E814 Standard Test Method for Fire Tests of Penetration Firestop Systems

D. Building Industries Consulting Services International (BICSI):

1. Telecommunications Distribution Methods Manual (TDMM)

E. Code of Federal Regulations (CFR):

1. 7 CFR 1755.890 RUS Specification for Filled Telephone Cables with Expanded Insulation

2. Bulletin 1753F-201 RUS Standard for Acceptance Tests and Measurements of Telecommunications Plant

F. Code of Federal Regulations, Federal Railroad Administration (FRA)

G. California Building Code (CBC)

H. California Electrical Code (CEC)

I. Electronic Components Industry Association (EIA/ECA):

1. 310-E 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 (ICEA):

1. S-84-608 Telecommunications Cable Filled, Polyolefin Insulated, Copper Conductor Technical Requirements

L. National Electrical Contractors Association (NECA):

1. Standard 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 Electric Energy

2. WC 70 Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy

3. WD 1 General Color Requirements for Wiring Devices

N. National Fire Protection Agency (NFPA):

1. 70 National Electrical Code (NEC)

2. 70E Standard for Electrical Safety in the Workplace

3. 72 National Fire Alarm and Signaling Code

4. 75 Standard for the Fire Protection of Information Technology Equipment

5. 101 Life Safety Code

6. 130 Standard for Fixed Guideway Transit and Passenger Rail Systems

7. 262 Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces

8. 780 Standard for the 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, Sensors, 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 Standards

4. 569 Telecommunications Pathways and Spaces

5. 606 Administration Standard for Telecommunications Infrastructure

P. Telecommunications Industry Association (TIA):

1. 598 Optical Fiber Cable Color Coding

Q. UL Solutions (UL):

1. 444 Communications Cables

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

3. 969 Standard for Marking and Labeling Systems

4. 1581 Reference Standard for Electrical Wires, Cables, and Flexible Cords

5. 1690 Standard for 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 a minimum range between -40 degrees Celsius and 90 degrees Celsius.

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 for wires and cables including complete technical information for each type of cable.

C. Submit Conduit fill calculations based on the submitted technical information for wires and cables. Conduit fill shall not 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. Communications cables 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 CAT 6A cabling to ensure all delivered cabling is within the vendor specified performance range upon arriving 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 systems shall be by CAT 6A cable.

B. Single-mode fiber shall be used as the station backbone fiber cable connecting the DC cabinets and the CER. Also, single-mode fiber optic cables shall be used for device connectivity as shown on Contract Drawings.

C. Single mode fiber optic cable shall be used for MPOE connectivity to Caltrain-Owned fiber optic plant for new station construction or rehabilitation projects as shown on Contract Drawings.

D. Subject to Engineer's approval, multi-mode fiber optic cables may be used for station rehabilitation projects only if such cables exist at the station and have sufficient strand capacity to accommodate the design. Otherwise, single-mode fiber optic cables shall be installed.

E. All installed copper and fiber cable throughout the station shall be suitable for the environment where they are installed. Provide outside plant cable, indoor cable, and indoor / outdoor cable types as described in these Specifications and as shown on Contract Drawings. 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.

F. 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.

G. 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.

H. 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.

I. 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.

J. Communications cables shall be type and size (number of pairs) identified for the installation of the various communications systems.

K. 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.

L. 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.

M. 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 CAT 6A CABLE

A. Category 6A cable shall meet the following requirements:

1. Polyethylene sheath

2. Low smoke, rated for 90°C

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

2.03 CAT 6A CABLE (AERIAL)

A. Aerial outside plant CAT 6A cable shall meet the following requirements:

1. Polyethylene sheath

2. Low smoke, rated for 90°C

3. Suitable for aerial application

2.04 RS-485/RS-422/RS-232D DATA CABLE

A. RS-485/RS-422/232D 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 pf/ft (12 pf/ft for RS-232D)

7. Resistance: $\leq$ 16 ohms/1000 ft (30 ohms/1000 ft for RS-232D)

2.05 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 described in this Section and as shown on Contract Drawings and only if approved by the Engineer. Such cable shall be outside plant and all dielectric.

B. Dielectric, gel free, loose tube single mode (and, if used, multi-mode) fiber optic cable shall be furnished. All fiber optic strands shall be terminated with SC or LC 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 ANSI/ICEA S-87-640.

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 waterproof tape.

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. See Section 17250, Fiber Optic Cable Distribution Subsystem.

2.06 SINGLE-MODE FIBER OPTIC PATCH CORDS AND FAN OUT ASSEMBLY

A. See Section 17250, Fiber Optic Cable Distribution Subsystem

2.07 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 larger 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 16 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.

2.08 T1 AND CATEGORY 6A 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 6A, 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.

G. Category 6A cable shall offer data transfer rates of 10 Gbps up to a length of 100 meters or 328 feet.

H. Category 6A cable shall have a minimum 500 MHz bandwidth capacity.

I. The Category 6A cable shall meet the ANSI/TIA-568.2-D standard.

2.09 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.

2.10 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: See Section 17250, Fiber Optic Cable Distribution Subsystem.

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 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.

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 designed 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. See Section 17250, Fiber Optic Cable Distribution Subsystem.

3.03 CABLE TIES

A. Ties shall be sized appropriately and rated for 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 General Requirements 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 6A 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 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.

10. For Category 6A cable, each link or channel shall be tested, and test reports submitted prior to cutover.

11. Category 6A cable testing shall meet ANSI/TIA 568 2.D requirements.

G. Testing Fiber Cables: See Section 17250, Fiber Optic Cable Distribution Subsystem.

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 the following major outdoor communications cabinets:

1. 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.

2. Station Communications Cabinets (SCC) or Communications Interface Cabinets (CIC) house the communications equipment required for all interfaces between the MDF or MPOE and the station's distribution cabinets and subsystems as shown on Contract Drawings. At stations where a Communications Equipment Room (CER) or a prefabricated house cannot be provided, the SCC or CIC shall be installed outdoor and shall contain the MDF or MPOE as described in Section 17050 and as shown on Contract Drawings.

3. Outdoor communication cabinets other than DC, SCC or CIC shall be provided where the design requires the installation of such cabinets to satisfy the operational and functional requirements of the station's subsystems. These cabinets shall be as described in this Section and in Section 17050, and shall be provided as shown on Contract Drawings.

1.03 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. B3 Standard Specification for Soft or Annealed Copper Wire

B. Electronic Components Industry Association (EIA/ECA):

1. 310 Cabinets, Racks, Panels, and Associated Equipment

C. National Fire Protection Association (NFPA):

1. 70 National Electrical Code (NEC)

2. 130 Standard for Fixed Guideway Transit and Passenger Rail Systems

D. National Electrical Manufacturers Association (NEMA):

1. 250 Enclosures for Electrical Equipment (1,000 Volts Maximum)

2. ICS 1 Industrial Control and Systems: General Requirements

3. ICS 4 Application Guideline for Terminal Blocks

4. ICS 6 Industrial Control and Systems: Enclosures

5. FB 1 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing (EMT) and Cable

6. WC 7 Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electric Energy

7. WD 1 General Color Requirements for Wiring Devices

E. California Electrical Code (CEC)

F. National Electrical Contractors Association (NECA):

1. 1 Standard for Good Workmanship in Electrical Construction

G. Telecommunications Industry Association (TIA):

1. 568 Commercial Building Telecommunications Cabling Standard

2. 607 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

H. UL Solutions (UL):

1. 50 Enclosures for Electrical Equipment, Non-Environmental Considerations

2. 50E Enclosures for Electrical Equipment, Environmental Considerations

3. 497 Standard for Protectors for Paired-Conductor Communications Circuits

4. 508 Standard for Industrial Control Equipment

5. 514A Metallic Outlet Boxes

6. 514B Conduit, Tubing, and Cable Fittings

7. 969 Standard for Marking and Labeling Systems

8. 1059 Standard for Terminal Blocks

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 Preliminary Design subsystem package for the communications cabinets:

1. Drawings showing the communications cabinet dimensions, layout (plan and elevations).

2. All calculations including heating/cooling (thermal calculations) and power requirements. Thermal calculations shall show that the equipment mounted inside the cabinet 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. Equipment and enclosure grounding details.

6. UPS and general purpose AC receptacles location, NEMA type and amperage ratings.

7. Product specifications for HVAC equipment (where required), intrusion device, fiber optic patch panel, Cat 6 patch panel, wiring blocks and communication and power circuit protection devices.

8. External Interface Details for Power Connections.

9. Door arrangement.

10. Mounting locations and supports for equipment mounted in the cabinets and/or enclosures.

11. Drawings showing space available for conduit entrance, knockout locations for routing and training of cables. Available space shall take into consideration bending radius requirements of cables.

12. Control schematics and relay logic with full narrative description of the control logic with reference to the device, relays, timers, contacts and components to be used for fabrication and installation.

13. Complete internal wiring diagrams.

14. Terminal strip designations.

15. Wire numbers.

16. Nameplates Schedule.

17. Layouts and templates if anchoring in concrete (if required).

18. Enclosure foundation details for floor mounted enclosures.

C. Final Design Technical Requirements: Include the following information as part of the FDR submittal package for the communications cabinets:

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 outdoor communications cabinet.

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 outdoor communications cabinets and shall include specific dates for installation.

b. Inspection Sheets shall be completed and submitted to the Engineer after installation of the cabinets. 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 communications cabinets testing requirements:

1. Test program plan: Include all the required information for the communications cabinets 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, include end-to-end testing plans including the cabinets' intrusion alarms.

5. System Integration Test: Where used, include System Integration test plan and procedures.

6. Provide a list of qualified staff to support in the tests as described in Article entitled Testing and Inspection herein. The list shall include the roles, responsibilities, and experience of each participant.

7. Provide a list of test equipment which includes the calibration date, standards, and other applicable information as described in Section 17000.

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 for each communications cabinet.

1.05 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 outdoor communications cabinet shall be a custom enclosure as described herein these Specifications and as shown on Contract Drawings.

2. Rated NEMA type 4X or 3R and vandal-proof outdoor communications cabinet. Where HVAC is required (as the result of thermal 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 will 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. DC shall be 24 inches (Wide) x 67 inches (High) x 30 inches (Deep). Dimensions of outdoor communications cabinets other than DC shall be as shown on Contract Drawings.

4. As (and if) required by the thermal calculations (calculated equipment BTU load), the cabinets shall be equipped with an air conditioner/heater. 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. Floor-mounted outdoor communications cabinets shall have a front side door and a back side door.

6. Doors shall provide seal via foam-in-place gasket, and shall be hinged and equipped with a 3-point lockable handle.

7. Outdoor enclosures shall be fabricated from 12-gauge stainless steel.

8. FDP shall be provided with a maximum of 72 connections for termination of single-mode fiber cables. Refer to Section 17250, Fiber Optic Cable Distribution Subsystem.

9. 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.

10. The Contractor shall install standard EIA- 310 E racks in the DC. 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.

11. 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.

12. A zinc plated steel pull out shelf shall be provided for supporting a local VMB input device.

13. UPS support hardware shall be provided. UPS power shall be provided as described in Section 17460, Power Supplies and Distribution.

14. A UL approved rack-mounted power strip and light bulb holder (with light bulbs) shall be provided for each door side of the floor mounted communications cabinet. The light bulbs shall be protected with a heavy duty wire cage.

15. All cables routed within the enclosures shall be organized and routed in conduit or flex tube for cable protection. The cabinets shall utilize the appropriate cable management hardware.

16. The inside cabinet (DCs) floor shall be at least 6 inches above the concrete pad on which the cabinet is located.

17. 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 members (such as racks, cable tray, panels) that are not stainless steel shall be painted black with corrosion inhibiting paint.

2.02 HVAC

A. Where required by thermal calculations, a floor-mounted outdoor communications cabinet 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 thermal 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.

H. The HVAC unit shall be ICE QUBE IQ8000VHA, IQ10000V or IQ12000V air conditioner/heater or Engineer approved equal.

2.03 CABLE ENTRANCES

A. The cabinet's 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/cabinet 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 outdoor communications cabinet so as to secure the entire cabinet. The locks shall have locking cylinders that match those used for other cabinets used in 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 floor mounted cabinet between the cabinet floor and the concrete pad shall be provided. The skirt shall be attached with vandal resistant stainless steel fasteners, and shall 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. The floor-mounted outdoor cabinets 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. The floor-mounted cabinet 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 manufacturer's recommended grounding conductor, or 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 CABINET LIGHTS AND INTRUSION ALARM

A. Provide an interior cabinet light on each side of the floor-mounted 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 UPS Dry Contact Alarm sensing (or, in the future, via Supervisory Control and Data Acquisition System (SCADA). The UPS shall be programmed for monitoring and reporting the alarms to CCF and BCCF.

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 cabinets shall physically and dimensionally support the equipment. This inspection shall take place before the cabinets leave the factory.

C. Factory Test and Inspection: Provide the Engineer with each test or inspection report after each test or inspection.

1. Inspect the cabinets at the Factory for cracks and other damage, and repair as required.

2. Inspect the cabinets 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. The outdoor equipment cabinets shall be installed at locations in stations as indicated on the Contract Drawings.

B. Floor Mounted Cabinets 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 concrete foundation as described in Section 17050 and 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 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. The ac power shall be conditioned by UPS, capable of maintaining backup power to all essential AC powered 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 CER 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 cabinet 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. Testing and inspection activities shall be performed per the Engineer approved submittals of the test plan and procedures. The Engineer shall be given a written notification prior to each test and inspection.

B. Inspect the cabinets for defects after they are installed in the field. This inspection shall verify proper installation and sealing of the cabinets and also ensure that there are no sharp edges that could pose a hazard to the public or the Engineer personnel.

C. Check that all cables and wires are properly terminated and that the terminations are correctly labeled.

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 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 all the equipment including lighting fixtures, intrusion sensors, equipment racks.

c. The inspection of the outdoor communications equipment cabinet's installation shall confirm that:

1) Conformance to installation requirements

2) Conformance to standards, methods and quality

3) Proper routing and termination of wire and cable

4) Secured cable and wire connections

5) Proper grounding of all equipment

6) 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 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 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

SECTION 17250

FIBER OPTIC CABLE DISTRIBUTION SUBSYSTEM

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	Standard for Optical Fiber Outside Plant Communications Cable
2.	TIA-455-177	Optical Fibers Part 1-43: Measurement Methods and Test Procedures - Numerical Aperture

B. ASTM International (ASTM):

1.	D1248-16	Standard Specification for Polyethylene Plastic Extrusion Materials for Wire and Cable
2.	E814-23a	Standard Test Method for Fire Tests of Penetration Firestop Systems

C. Code of Federal Regulations (CFR):

1.	7 CFR 1755.902	Minimum Performance Specification for Fiber Optic Cables

D. Telecommunications Industry Association (TIA)/ Electronics Industries Alliance (EIA):

1.	TIA-455-B	Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and other Fiber Optic Components
2.	TIA-455-3	FOTP-3 Procedure to Measure Temperature Cycling Effects on Optical Fiber Units, Optical Cable, and Other Passive Fiber Components
3.	TIA-455-13	FOTP-13 Visual and Mechanical Inspection of Fiber Optic Components, Devices, and Assemblies

4.	TIA- 455-25	FOTP-25 Impact Testing of Optical Fiber Cables
5.	TIA-455-33	FOTP-33-B Optical Fiber Cable Tensile Loading and Bending Test
6.	TIA- 455-37	FOTP-37 Low or High Temperature Bend Test for Fiber Optic Cable
7.	TIA- 455-41	FOTP-41 Compressive Loading Resistance of Optical Fiber Cables
8.	TIA-455-78	FOTP-78-B Optical Fibres - Part 1-40: Measurement Methods and Test Procedures - Attenuation
9.	TIA-455-133	FOTP-133 Optical Fibres - Part 1-22: Measurement Methods and Test Procedures - Length Measurement
10.	TIA- 455-81	FOTP-81 Compound Flow (Drip) Test for Filled Fiber Optic Cable
11.	TIA-455-82	FOTP-82 Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable
12.	TIA- 455-85	FOTP-85A Fiber Optic Cable Twist Test
13.	TIA- 455-88	FOTP-88 Fiber Optic Cable Bend Test
14.	TIA-455-91	FOTP-91 Fiber Optic Cable Twist-Bend Test
15.	TIA-455-104	FOTP-104 Fiber Optic Cable Cyclic Flexing Test
16.	TIA-455-171	FOTP-171 Attenuation by Substitution Measurement for Short Length Multimode Graded lndex and Single-Mode Optical Fiber Cable Assemblies
17.	TIA- 455-181	FOTP-181 Lightning Damage Susceptibility Test for Fiber Optic Cables with Metallic Components
18.	TIA -4720000	Generic Specification for Fiber Optic Cable
19.	TIA-492-CAAB	Detail Specification for Class IVa Dispersion - Unshifted Single-Mode Optical Fibers with Low Water Peak
20.	TIA-526-7	Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
21.	TIA-526-14	Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant

22.	TIA-568	Commercial Building Telecommunications Cabling Standard, components of fiber optic cable systems
23.	TIA-598	Optical Fiber Cable Color Coding
24.	TIA -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 compatible. Single-mode fiber optic cable shall be deployed on the station facility and platform grounds inside CER cabinets and between CER and the DC. Station communications with CCF, BCCF and JPB Headquarters shall be over Caltrain-owned single-mode fiber optic plant.

2. The station's backbone single-mode 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 unless shown otherwise on Contract Drawings. The single-mode fiber optic cable shall be of outside plant design for outdoor applications and plenum design for indoor applications. All fibers shall be terminated, tested and certified, whether in-use or spare (dark).

3. Provide Single-mode fiber optic cables for device connectivity as shown on Contract Drawings. The cable shall be suitable for outdoor application and shall consist of 6-strands minimum unless otherwise shown on Contract Drawings.

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

5. 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.

6. 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.

7. 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.

8. Use of Multi-mode fiber cable and the associated equipment solutions shall be avoided and can only be permitted as an exception (due to lack of adequate substitute based on single-mode fiber solution, or if the station's existing multi-mode fiber cable has the capacity required of the design) 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 submittals 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.

M. Splicer Qualifications: Submit detailed resumes of experience for the proposed technician(s) demonstrating a minimum of five (5) years' experience in performing fusion splicing of fiber optic cabling, work experience on at least two (2) projects with fusion splicing of fiber optic cabling, and completion of 1,000 splices each year. Submit name(s), address(es), and telephone numbers of person(s) who can verify the technician's work experience.

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

1) 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.

2) The cable manufacturer shall be ISO 9001 certified.

c. Warranty

1) 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.

2) 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.

3) 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 1755.902 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. The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.

8. 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:

1. The single-mode fiber utilized in the optical fiber cable shall meet ITU recommendation G.652.D; IEC Standard 60793-2-50 type B.1/G.655-G.655A).3; Telcordia GR-20-CORE; ANSI/ICEA S-87-640; and RUS 7CFR1755.902.

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
      @ 1310 nm (µm) = 8.9 ± 0.3

   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) ≤ 0.1

d. Cable Cutoff Wavelength (λccf) (nm) ≤ 1260

e. Total Dispersion (ps/(nm•km))

1300 nm = ≤ 3.0
1530 – 1565 nm = ≤ 18.0
1565 – 1625 nm = ≤ 22.0

f. Cabled Polarization Mode Dispersion (ps/km) ≤ 0.1 max

g. Water Peak Attenuation @1383+/- 3 nm; ≤ 0.4 dB/km

4. Environmental and Mechanical Specifications:

a. Temperature Range: -40°C to +70°C (operation and storage)

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

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

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

e. Cable Outside Diameter equal or < 0.65 inch

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

g. Minimum Bending Radius:

Installation, 15X Diameter
Static, 12X Diameter

h. Tensile Strength:

Installation 600 lb
Maintained 200 lb

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

a. The cable shall meet the specifications set forth in Bellcore GR-20-CORE. Cable shall be 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 1755.902.

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

g. 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.

h. 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.

i. 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.

j. 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.

k. 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.

l. 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, and a telecommunication handset symbol as required by Section 350G of the National Electrical Safety Code (NESC). 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.

m. 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.

2.02 FIBER CONNECTORS AND PASSIVE COMPONENTS

A. Fiber Connectors:

1. FDP connectors shall be SC or LC type. SC or LC type connectors shall be the preferred connector for all terminations to the fiber distribution panel. SC, LC and other type of connectors shall be provided for termination onto switches, media converters and other communications devices as required by the mating connector of the equipment.

2. When available network products use connectors other than SC or LC type, optical patch cables shall be provided with the corresponding non-SC or LC type connector on the equipment end, and the SC or LC type connector on the distribution panel end.

3. Optical parameters of the connectors shall meet the requirements of TIA-568.

4. SC or LC type single-mode fiber connectors shall be provided for termination onto the fiber patch panel as shown on Contract Drawings. SC or LC type fiber connectors shall be of a design that offers quick field installation, no epoxy and no polish, maximum insertion loss of 0.7 dB, composite housing material, and ceramic or composite ferrule material.

5. SC or LC type single-mode fiber connectors shall be Corning, Unicam connectors or 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 Splice Enclosure:

1. Enclosure

a. Fiber splice enclosures shall be provided as described in the Specifications and as shown on Contract Drawings. The enclosure shall provide storage and protection of fiber splices. The enclosure shall house splice trays for splicing a minimum of 48 fiber strands. The splice trays shall be compatible with the housing and shall be easily accessible. Cable entry ports shall be grommeted.

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.

d. Splice tray shall be suitable for heat-shrink fusion splices of 12 fiber strands minimum.

2. Fiber splice enclosure shall be Tyco, Commscope 450 series, or Engineer approved equal. Splice trays shall be Tyco, Commscope, or Engineer approved equal.

D. Fiber Distribution Panels:

1. Fiber Distribution Panels (FDPs) 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 accept a variety of connector panels options that 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 and 606.

4. The FDP shall be UL Listed in compliance with UL safety standards.

5. The connector housings design shall have features that include ease of installation, accessibility for testing and troubleshooting, cable strain relief, routing clips, mounting brackets and a labeling scheme that complies with TIA/EIA-606.

6. The housing shall include removable front door, removable top covers and slide out tray.

7. The connector panel assembly shall include SC or LC type connectors, factory preloaded and tested pigtails and a splicing chamber suitable for fusion splicing which eliminates the need for individual splice trays. The connector panel assembly shall provide for quick and ease of installation and shall eliminate the need for splice closures or splicing trays. The SC or LC type connectors shall be as shown on Contract Drawings.

8. The FDP shall be Corning, CCH series or Engineer approved equal. The connector panel assembly shall be Corning, CCH-CS-12 series or Engineer approved equal.

E. Field Device Fiber Patch Panel:

1. The fiber patch panel shall be of a compact design installed at the end device as shown on Contract Drawings. These patch panels are used to facilitate the connectivity of the device to the DC or CER.

2. The patch panel shall be rugged and suitable for installation in outdoor enclosures and pedestals. It shall have a minimum capacity of terminating 6-strands fiber optic cable.

3. The patch panel shall have factory installed SC or LC type connectors with pre-loaded and tested pigtails terminated to an Optitip adapter. The fiber optic cable that connects to the fiber patch panel shall have a mating Optitip connector installed and tested by the cable manufacturer.

The length and type of the cable shall be as shown on Contract Drawings.

4. The field device fiber patch panel shall be Fiber Connections, Inc., Gatorpatch or Engineer approved equal.

2.03 OPTICAL FIBER PATCH CORDS AND PIGTAILS

A. Patch cords and pigtails shall be cable assemblies consisting of flexible optical fiber cable with a connector combination as required by the design and as shown on Contract Drawings. 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.

C. Connectors:

1. The patch cord connectors shall be compatible with the type of connectors on the equipment where the patch cord is to be installed.

2. Composite housing, UPC polish, and ceramic or composite ferrule material connectors shall be provided.

3. Single-mode connectors housing shall be colored blue.

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. Fiber patch cords shall be Corning, Fiber Optic Jumpers assemblies or Engineer approved equal.

2.04 INNERDUCT

A. Innerduct shall be constructed of HDPE 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. Innerduct installed in any air plenum environment shall meet NFPA 262 requirements.

B. Innerduct shall have smooth exterior and interior wall, and semi-rigid construction.

C. Inside building horizontal and riser innerducts 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 innerduct shall be preinstalled with lubricated pull tape or line.

H. Innerduct used to house single-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: ≤ 0.055

3. Temperature Range: -28 degrees F to 180 degrees F

4. Compatible with all cable types

2.06 DETECTION WIRE (TRACER)

A. Detection wire shall meet the following requirements:

1. #14 AWG

2. Copper-clad steel (CCS)

3. HDPE Insulated

2.07 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 850nm, 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. Notify the Engineer in writing at least one week in advance of terminating each section of optical cable.

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 TIA-568 (or by the required network application standards) whichever is more demanding.

5. TIA-568 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.

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. The test instrument calibration date shall be within the calibration period recommended by the vendor in order to achieve the vendor specified measurement accuracy.

9. 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.

10. The Pass or Fail condition for the link-under test is determined by the results of the required individual tests.

11. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter.

12. 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.

13. 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:

1) Single mode (outside plant), 1310nm: 0.5 db/km

2) Single mode (outside plant), 1550nm: 0.5 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. 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.

5. 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 and up to 40 Gigabit Ethernet.

6. 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 bi-directionally.

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 result 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

SECTION 17460

POWER SUPPLIES AND DISTRIBUTION

PART 1 - GENERAL

1.01 DESCRIPTION

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

1.02 REFERENCE STANDARDS

A. American National Standards Institute (ANSI):

1.	C2	National Electrical Safety Code
2.	C62.41	Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits

B. California Electrical Code (CEC)

C. Federal Communications Commission (FCC):

1.	Title 47, Part 15, Subpart J Class A	

D. Institute of Electrical and Electronics Engineers (IEEE):

1.	519	Standard for Harmonic Control in Electric Power Systems
2.	3003.1	Recommended Practice for System Grounding of Industrial and Commercial Power Systems
3.	3003.2	Recommended Practice for Equipment Grounding and Bonding in Industrial and Commercial Power Systems
4.	3005.3	Recommended Practice for the Application of Stored-Energy Systems for use in Emergency and Standby Power Systems

E. International Electrotechnical Commission (IEC):

1.	60068-1	Environmental Testing Part 1: General and Guidance
2.	61000-4-2	Electromagnetic compatibility (EMC)-Part 4-2: Testing and measurement techniques - Electrostatic Discharge Immunity Test

F. National Electrical Manufacturers Association (NEMA):

1.	PE 7	Communications Type Battery Chargers

G. National Fire Protection Association (NFPA):

1. 70 National Electrical Code (NEC)

2. 75 Standard for the Fire Protection of Information Technology Equipment

3. 101 Life Safety Code

4. 130 Standard for Fixed Guideway Transit and Passenger Rail Systems

H. UL Solutions (UL):

1. 1449 Surge Protective Devices

2. 1778 Uninterruptible Power 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) and other communications equipment cabinets 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 and BCCF UPS Alarm Monitoring System. Coordinate with the Engineer end-to-end testing and reporting of such alarms at CCF and BCCF.

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 and BCCF. 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.

   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. The UPS power rating shall meet the peak load plus an 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 an appropriate Professional Engineer licensed in 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) and station devices, refer to Standard Drawing SD-4820 for details. For stations where a UPS system cannot be accommodated in the CER, then stand-alone rack mount UPS with backup batteries shall be provided.

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

B. DC Supply:

1. DC supplies (24VDC and 48VDC) (and, if required, other power supplies) shall be provided for 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 from a utility service.

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 be a true on-line, double conversion three-phase UPS system. The UPS shall continuously condition the power input and regulate it and shall

include microprocessor controlled switch circuitry that provides for instantaneous transfer from on-line to battery to ensure no disruption of power to the load.

1. The load shall normally be powered from the inverter which is the secondary conversion unit of the UPS; the rectifier which is the primary conversion unit 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 UPS system shall use insulated-gate bipolar transistors (IGBT) technology used in modern high efficiency UPS systems.

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. The UPS shall monitor and control the charger.

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: 3-phase 120/208 VAC (if approved by Engineer, 277/480 VAC), Nominal

2. Output Voltage: 3-phase 120/208 VAC, Nominal

3. Voltage Regulation: Voltage Regulation: ±1% Static; <5% dynamic at 100% resistive load change with input -15%, +20% from nominal

4. Noise Attenuation: 120 dB Common Mode, - 60 dB Transverse Mode

5. Output Frequency: 60 ± 0.005 Hz

6. Waveform Type: Sine wave

7. Input AC Overload Capacity: 125 percent Rated (10 Min), 150 percent (Surge)

8. Output Waveform Distortion: less than 2% total harmonic distortion.

9. Operating Temperature: 0 degrees to 40 degrees Celsius

10. Operating Humidity: Up to 95 percent Relative Humidity (R.H.)

11. Line Powered Efficiency: 88 percent average with a minimum of 90% efficiency above 50% load.

12. Audible Noise: Varies by size of UPS but to not exceed 65 dBA at 1 meter from the UPS surface.

13. EMI Suppression: The UPS shall meet FCC Title 47, part 15, subpart J, for class A devices.

14. Mean-Time-Between-Failures: 100,000 Hours

15. Transfer time from line power to internal battery: 1 ms maximum.

16. 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. Rectifier: The rectifier 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 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. Normal on-line mode

c. Standby mode

d. Economy mode

e. Bypass mode

f. Battery mode

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.

K. The UPS shall be Tripp-Lite, Smart online SUT or Engineer approved equal.

2.03 DC POWER SUPPLIES

A. Communications Cabinet:

1. When applicable, 24VDC 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.

C. The power supply shall be Lambda, DLP series or Engineer approved equal.

2.04 STAND ALONE UPS

A. Stand-alone UPS units shall be provided as described here in these specifications and as shown on Contract Drawings.

B. The UPS shall be on-line double conversion type, 120 V single phase with auto sensing input frequency.

C. The UPS output voltage shall be 120 VAC with output frequency synched to mains. The waveform type shall be Sine wave. Output connections shall have NEMA type receptacles.

D. Input connections shall be NEMA L5-30P or 5-20P type as required for the size of the UPS provided.

E. The UPS shall be provided with a network card and I/O card for remote control and indications. It shall also be equipped with a control panel and audible alarms.

F. The UPS shall meet the FCC rules and regulation 47, part 15, subpart J, for class A devices

G. The UPS shall have the following features:

1. Operating temperature: 0- 40 degrees C

2. Operating Relative Humidity: 0-95%

3. Audible Noise: 55 dBA at 1 meter from the UPS

4. The UPS shall have built-in protection against AC surges.

H. The UPS shall be APC, smart-ups SRT series or Engineer approved equal.

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.

E. 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
VARIABLE MESSAGE SIGN

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes requirements for a Variable 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 Commercial Building Telecommunications Cabling Standard (including B.1, B.2, and B.3)

2. 606 Administration Standard for Telecommunications Infrastructure

C. Americans with Disabilities Act (ADA):

1. Federal Transit Administration Title 49 CFR Part 37 Appendix A

D. Department Of Defense Design Criteria Military Standard (MIL-STD):

1. 1472 Human Engineering

1.03 SYSTEM REQUIREMENTS

A. The Variable Message Sign shall support a wide range of character sizes for displaying 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. Variable Message Sign equipment shall include matrix display signs with attached sunshades, bird deterrent, 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) and Back-up Central Control Facility (BCCF).

D. The VMS shall be capable of displaying both text and 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.

F. The VMS shall have features that include flexible mounting options and outdoor rated enclosure.

G. Dual-face and single-face displays shall be installed as shown on Contract Drawings. A minimum of two dual-face displays shall be installed on one platform. Single-face displays shall be provided as required by the design.

H. The VMS shall communicate wirelessly or over single-mode fiber optic cable as shown on the Contract Drawings. Communications with CCF and BCCF shall be over Caltrain owned fiber optic plant.

I. The VMS shall easily integrate with the existing Passenger Information Display System (PIDS) at CCF and BCCF.

J. The VMS subsystem shall use VLAN IP-based network operating at a minimum of 100Mbps. IP address shall be assigned all the VMS in the network. CCF and BCCF shall be able to message individual stations, a group of stations, or all stations as required.

K. The VMS shall be capable of displaying static and dynamic message contents on the same page. Content effects to include but not be limited to flash, scroll, travel, roll, split, and static or moving images.

L. The VMS shall be capable of displaying variable text sizes and font types and shall support characters of other languages as configured by the Caltrain Predictive Arrival/Departure System (PADS) including scroll speed, colors, etc.

M. The display shall have full-color capabilities with 3 LEDs (RGB) per pixel.

N. The VMS shall support date and time messaging, priority and emergency messaging, and wipe running messages based on priority levels and interrupt commands from the PADS control system. For non-critical failure, the sign shall be capable of displaying static messaging such as train schedule.

O. In the event of a critical failure, the VMS screen shall be blank.

P. The VMS shall be compatible with the existing Caltrain PADS system. PADS shall communicate with the sign using the existing Data Vision Software (DVS) built-in REST API scheme. If the sign does not communicate with the existing DVS, the Contractor shall be responsible for modifying the PADS system to ensure the sign functions properly.

Q. Each VMS shall have a unique IP address on a VMS VLAN as provided by Caltrain to match the existing IP configuration.

R. In the event of a primary server failover or cutover, the signs shall automatically accept commands from the primary PADS system server in control without any need for manual intervention. These servers could be geographically separated, and in a cold and/or hot standby.

S. The sign shall provide diagnostic support including but not limited to reporting real time alarms and faults to PADS.

T. The sign shall permit remote troubleshooting for general faults and network specific problems from the central control system.

U. The sign shall permit remote resets and restarts from the central control system and shall provide self-diagnostics and automatic resolutions including auto-rebooting.

V. Any modifications to the architecture or functionality of the existing PADS system are subject to review and approval by Caltrain.

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.

H. Warranty: Submit manufacturer warranty documentation for the VMS. The warranty period shall be a minimum of five (5) years.

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 VARIABLE MESSAGE SIGNS (VMS)

A. Each VMS shall be individually addressable from the assigned CCF and BCCF 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, BCCF or a local input device connected directly to the VMS.

C. Locally generated messages shall take priority over the assigned CCF and BCCF generated messages.

D. The VMS shall be capable of displaying multiple text styles and sizes, graphics, and logos, images on a large bright screen of high intensity light emitting diodes (LED). The display shall have the following characteristics:

1. The VMS shall meet ADA requirements

2. Automatic intensity control

3. Full color RGB display with a maximum of 0.25" pixel pitch

4. Multiple fonts

5. Multiple display effects; flash, scroll, roll, graphics

6. One to four line text

E. Each VMS shall be capable of storing 32 preprogrammed messages.

F. 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.

G. The VMS shall be equipped with manufacturer's standard sunshade.

H. 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.

I. Supply double-sided and single-sided variable message signs as shown on the Contract Drawings. The double-sided message boards shall be Daktronics Model AF-6710-32X192-6-RGB-DF or Engineer approved equal. The single-sided message boards shall be Daktronics Model AF-6710-32X192-6-RGB-SF or Engineer approved equal. Each VMS shall conform to the following:

1. Display Characteristics:

a. 120 VAC input power. Power usage shall not exceed 370W.

b. Includes factory installed disconnect means

c. Includes factory installed power filter and power supplies

d. Effects: flash, scroll, travel, roll, split, graphics

e. Character height: variable

f. Messages: multi and single line, minimum requirements of 2-lines of text, each line a minimum of 3.1" high and legible from 21 feet to meet ADA Standards for Transit Facilities.

g. Viewing angle: 120 +/- 2 degrees

h. Display dimming: a minimum of 99 levels automatic or manual control.

2. Physical Characteristics:

a. Enclosure: NEMA 4X/IP 65

b. Double-sided sign dimensions shall not exceed 14.5" H x 52.5" W x 13.75" D. Single-sided sign dimensions shall not exceed 14.5" H x 52.5" W x 8.5" D.

c. Display window: shatter-proof, vandal resistant, ultra-violet resistant, condensation prevention

d. Metal components shall be corrosion resistant and shall withstand extreme weather conditions.

e. Maintenance access: access doors on each side of double-sided sign. Front access for single-sided sign.

f. Weight of the sign shall not exceed 140 pounds for double-sided signs and 120 pounds for single-sided signs.

g. The VMS shall have an operating temperature range of 35° F to 115° F.

3. The display shall have an additional LAN port for laptop connectivity and localized sign troubleshooting.

J. Cables: Cables shall conform to the requirements of Sections 16100, Wiring Methods, 17120, Communications Wires and Cables, and 17250, Fiber Optic Cable Distribution Subsystem.

K. Network Connectivity: The VMS shall come equipped with a factory installed Ethernet to serial converter with a standard RJ-45 port for network connectivity.

L. Compact Fiber Distribution Panel (FDP): Compact fiber distribution panel shall have a pigtailed connector panel with 12 SC type connectors for terminating single mode fiber optic cable inside the VMS sign. The compact FDP shall be Corning SPH-CS12-59-P00RE or equal.

M. Media converter: The media converter shall be of miniature size hardened 10/100/1000Base-T to 1000 Base-LX with RJ-45 and single mode SC ports, suitable for extreme environments.

The media converter features shall include auto-negotiation, full duplex on fiber and auto medium-dependent interface on copper ports and status LEDs. The media converter input power shall accept voltages ranging from 12 VDC to 48 VDC.

The media converter shall be Transition Networks M/GE-ISW-LX-01 or equal, with manufacturer-recommended power supply.

N. The VMS displays shall be powered by Uninterruptable Power Supplies to prevent loss of emergency passenger communications for 90 minutes.

O. Mounting: Provide the VMS mounting as shown on the Contract Drawings, including all foundation work, stanchions, mounting brackets, and bracing.

P. 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.

Q. Sunshade: Provide sunshades along with manufacturer's mounting hardware. No field drilling into the sign will be permitted. The sunshade shall be Daktronics AF-671X-32X192-6-Sun Visor or equal.

R. Bird deterrent: Bird deterrents shall have stainless steel spikes and a UV polycarbonate base. Bird deterrent shall not be screwed to the sign. Provide manufacturer recommended silicone glue to bond the base to the sign. Bird deterrent shall be Bird.B.Gone, BBG2001/8 or equal.

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. Ground the VMS display per manufacturer's instructions.

E. 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.

F. Install VMS stanchions, including pole, support arms, and foundation, as shown on the Contract drawings and as specified in the Contract Specifications.

G. Mount VMS on stanchions. Verify that all mechanical connections are made and secure.

H. 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.

I. 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 with 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 and BCCF 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 BCCF and they work as specified with the station.

3. Verify on each VMS the display of the CCF and BCCF 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 17760
RAIL NETWORK

Caltrain Rail Network Standard Specifications are to be developed. Please contact Caltrain Systems Engineering if specifications are needed for the following elements of the Rail Network:

1. Data centers
    - Remote access (vendors and internal staff)
    - Railroad partners communication (Federated Links)
    - Physical requirements (power and power redundancy; cooling)
    - Network segmentation (critical networks; administrative; CCTV)
2. LAN
3. WAN
4. Security
    - Cyber Security (Intrusion detection/Intrusion prevention)
    - Perimeter security
    - Physical security
5. GBN (ground-based network)
6. Data Radio system architecture
    - 220 MHz architecture
    - Onboard Communication package
    - Wayside Communication Package
    - Backhaul Communication package
7. WLAN Architecture
8. Telephony
9. Data back up and disaster recovery

10. Logging
11. System monitoring
12. Alerts system
13. Systems change management procedure
14. Network equipment technical support from the vendors (for example Cisco TAC)
15. Server infrastructure technical support (for example Dell)
16. Continuity plan
17. Emergency plan

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. Provide all necessary conduits, cables, and cabinets to interconnect the local 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.

B. 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.

C. Stations from San Francisco to Tamien shall communicate using Caltrain-owned fiber optic plant. For stations south of Tamien, the existing leased service shall be upgraded to a "full" T1 service (1.544 Mbps).

D. 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.

E. Use a single-mode fiber optic ring topology for all station 1000 BASE FX switch interconnectivity.

F. GBIC modules shall be provided for each GBIC-based port in the switch.

G. 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.

H. 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 way that, if one of them fails, field devices connected to the failed switch could be manually reconnected to the remaining (healthy) switch ports.

I. 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 6A) cable. Where required by design, the subsystem devices shall be PoE powered by the switches over the Category 6A 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.

J. 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.

K. 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 6A 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.

L. Wireless equipment to connect an extended range system device to the distribution cabinet where conventional UTP or fiber cable placement is not 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 568, a wireless link can be used, with the Engineer's approval.

M. Access requests to the Caltrain network require consultation with the Engineer; upon Engineer's approval, provide a firewall router to access the Caltrain network.

N. Should network equipment specified herein become obsolete or should an upgraded model become available, replace the specified equipment with the most current available model with Engineer's approval. Submit full technical specifications for the replacement equipment for Engineer review prior to purchase.

O. 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 the station CID Router, CID Ethernet Switches and CID devices (Caltrain furnishes the CID poles and poles temporary covers for installation by the contractor). 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 6A cabling, utilizing existing Category 6A 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, patch cords, and cables to interconnect 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 the Clipper communications network utilizes some of the Caltrain backbone cabling and patch panel equipment, such Caltrain network equipment design shall accommodate these additional connections.

C. Clipper equipment, including router Ethernet switches, 24 VDC power supplies, and CIDs will be provided by Clipper. All conduit and cable between the CID and distribution cabinet will be provided by Clipper.

1.04 CALTRAIN COMMUNICATIONS NETWORK DESIGN REQUIREMENTS

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 thermal calculations showing that the 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 manufacturer warranty documentation 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 a rugged switch designed for the harsh, rugged transit environment.

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 TX, PoE, and fast Ethernet SFP ports to service the required number of subsystem devices assigned, plus 50% spare ports.

D. The switch shall be equipped with at least two Gigabit Ethernet uplink SFP ports.

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 provided with dual power supplies, hot swappable and field replaceable.

I. The switch shall be provided with Small Form-factor Pluggable (SFP) modules compatible with the fiber optic cable type as shown on Contract Drawings.

J. Provide two Ethernet switches in the distribution cabinet. Refer to Standard Drawing SD-4804.

K. The switch shall be the Cisco IE-4010 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 single mode SFP ports (with additional two single-mode SFP ports programmed as spare for connection to future Caltrain fiber WAN network).

B. The switch shall be sized for an adequate number of 10/100/1000 Base T, PoE, and SFP 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.

E. The switch shall provide for ability to upgrade uplink bandwidth to 10 Gigabit Ethernet.

F. 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.

G. The switch shall be provided with network and SFP modules compatible with the fiber optic cable type as shown on Contract Drawings.

H. The switch shall be the Cisco Catalyst 9300 series or Engineer approved equal.

2.03 STATION ROUTER

A. Router shall be rack-mountable.

B. The router shall be highly reliable with IP LAN connection and proper WAN interface module.

C. The router shall have two high speed Ethernet ports or modules. The router shall be high performance router capable of running multiple concurrent services including encryption, traffic management, and optimization, without compromising data throughput.

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 4000 integrated services series or equal. Router is dependent on the type of network interface (T1, DSL, ADSL, OC3) used. The router network interfaces and modules shall include wireless WAN, E1/T1, broadband, and voice.

G. Voice Interface Cards:

1. For PA System and Fire Alarm system, provide and install two E&M Interface Cards and two FXS Interface Cards in the network router, including interface modules or other necessary items for a fully functioning system.

2. Provide the following models (or Engineer approved equal):

   a. E&M: Cisco VIC3-2E/M voice interface card for RJ-45 VOIP connection.

   b. FXS: Cisco VIC3-2FXS/DID voice interface card for standard RJ-11 telephone connection.

2.04 SMALL FORM-FACTOR PLUGGABLE (SFP) MODULES

A. The SFP modules shall be furnished and installed to connect among the Station Aggregation Ethernet Switch and distribution Ethernet switches.

B. The SFP modules shall be hot swappable to minimize serviceability. Fiber optic SFPs shall support digital optical monitoring (DOM).

C. The SFP 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

D. The SFP 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.

E. The switch shall have Single-mode SFP 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 require by the Station network design.

B. The firewall router shall be Next generation Fire Wall featuring Next Generation Intrusion Prevention System and shall have a minimum of 4 copper and 4 fiber interface ports.

C. The firewall router shall have a minimum throughput of 2 Gbps and shall have a warranty from the manufacturer.

D. The firewall router shall be the Cisco Firepower 1000 series bundle 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.

C. Managed and unmanaged media converters shall be provided as required by the design. Media converter input power shall be as shown on Contract Drawings.

D. Managed media converter shall be Rugged Com, RMC series, or Engineer approved equal. Unmanaged media converter shall be Transition Networks, M/E-ISW series or Engineer approved equal.

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 1U or Engineer approved equal.

2.08 UTP PATCH CORDS

A. Patch cords shall be Category 6A, 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 6A unshielded twisted pair cabling, and shall terminate all eight positions of the connector.

2.09 FIBER PATCH CABLE

A. Refer to Section 17250 Fiber Optic Cable Distribution Subsystem for requirements.

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 as shown on Contract Drawings.

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

9. LCD Console Drawer shall be Tripp Lite, B021 series or Engineer approved equal

2.12 KVM SWITCH

A. Rack mount KVM switch used for programming the router, switch and other device shall be furnished and installed as shown on Contract Drawings.

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 1920x1440

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

13. KVM switch shall be Tripp Lite B022 series or Engineer approved equal.

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-569 and properly grounded according to TIA-607 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-606.

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 4000 series or approved 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 wring.

2. Install WIC (WAN Interface Card) as shown on Contract Drawings. 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 or connecting to JPB owned fiber optic plant at the station as shown on Contract Drawings, and for establishing and providing all required hardware and software for setting up the station communications systems.

2. Install and setup a T1 circuit in the station, or fiber optic cable drop for connection to JPB owned fiber optic plant as shown on Contract Drawings.

F. Provide all equipment necessary, including router, WAN Interface Card, CSU/DSU, fiber equipment, 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 NEW AND REMODELED STATIONS

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.

5. The fiber cables from the station distribution cabinet to the distribution cabinets shall be installed and tested.

6. The UTP or fiber cable to the TVM machines, VMS signs, and other devices shall be terminated and tested.

7. UTP and fiber cable test results 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. Audio Engineering Society (AES):

1. 67 AES Standard for audio applications of networks – High-performance streaming audio-over-IP interoperability

B. Federal Communications Commission (FCC):

1. Title 47, Chapter 1, Subchapter A, Part 15

C. International Electrotechnical Commission (IEC):

1. 61000-4-2 Electromagnetic compatibility (EMC) Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test

D. National Fire Protection Association (NFPA):

1. 70 National Electrical Code (NEC)

E. Local noise ordinances

F. 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. The PA system shall be able to initiate PA announcements either remotely or locally. Primary communication of announcements shall be from the Central Control Facility (CCF) or Back-up Central Control Facility (BCCF). PA announcements to the station shall be 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.

3. 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.

4. 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 and BCCF 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.

5. Support Engineer in testing the operation of PA system at the stations from Central Control Facility (CCF) and Back-up Central Control Facility (BCCF).

6. 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, BCCF, 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 as shown on Contract Drawings. 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 about 12 dB over measured ambient.

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 and BCCF 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. Where an agent office exists, provide a wireless paging microphone that would allow the station agent to make PA announcements.

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 / BCCF PA: Top Priority

2. Local PA via push-to-talk wireless microphone/handset (Where applicable): Second Priority

3. Local PA via push-to talk hardwired paging microphone (Where applicable): Third Priority

4. Local paging microphone at the station platform: Fourth Priority

5. Cell/Public/Private Phone Messages: Fifth 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 equipment's 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 the Contract Documents. Training shall include operation, maintenance and troubleshooting of the new PA system for 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 400 – 7500 Hz Nominal

5. Dispersion Coverage: 60° H x 40° V

6. Speakers shall be the Atlas Sound, model APX40TN or Engineer approved equal

7. 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. Each station shall be provided with a minimum of two amplifiers configured in a redundant manner so that half of the speakers on each platform, concourse, waiting rooms at terminals, etc., remain operational if one amplifier fails. The power amplifier(s) two output channels shall be wired such that one channel is connected to half the speakers on one platform and the other channel to half the speakers on the other platform as shown on Contract Drawings. Stations with center platform shall be provided with two amplifiers with the output channels connected as shown on Contract Drawings. Amplifier input shall match the outputs of the Pre-Mixer/Pre-amplifier and accommodate its PA zone specific ambient noise compensator.

2. Frequency Response: 20 Hz to 20 kHz $\pm$ 0.5 dB

3. Output Level: Constant 70.7 volts (nominal), transformer isolated

4. Amplifier Digital Signal Processing: 96kHz, 32 bit floating point

5. Amplifier Protection: Amplifier shall have protection circuits against shorted outputs, mismatched loads, overheating, over and under voltage and high frequency overloads.

6. 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.

7. Harmonic Distortion: Maximum 0.5 percent from 20 Hz to 20 kHz

8. All indicators and controls shall be accessible from the amplifier front panel

9. BLU Link I/O Ports: The amplifier shall be capable of transporting audio signals over BLU Link. The amplifier shall have two RJ45 BLU Link ports.

10. Have an Ethernet Network Port, 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. The Ethernet port shall be RJ45.

11. The Amplifier shall be equipped with general purpose input output connector block. The I/O shall be configurable for amplifier status and control.

12. EIA 19-inch rack mountable

13. The amplifier shall be the Crown CDI DriveCore 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:

1) Analog Input Modules, each providing for 4 line/mic inputs

2) Hybrid Input Modules, each providing for 1 phone and 2 line/mic inputs

h. Provide for flexible software allowing for the following:

1) monitoring the ambient sound level at the associated station area and automatically adjust the output level of the power amplifiers

2) ability to automatically adjust the output of the system to meet day time and night time noise abatement requirements of local municipalities

3) filter "clicking," "pitching" and any other unsettling or undesirable sounds as specified in these specifications

4) elimination of positive feedback for all stationary and mobile microphones used by the new PA system (if applicable)

5) capable of accepting flexible controls, switch and volume adjustment tools for various PA zones

6) capable of implementation the contract specified priority scheme for various remote and local PA announcements

i. Contain an Ethernet interface port 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. Capable of transporting quality, low latency audio by using standard IP over 100Mb and 1Gb Ethernet.

k. EIA 19-inch rack mountable

l. The pre-mixer/pre-amplifier shall be a networked unit by BSS Audio, model BLU-806DA 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 7 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.

4. The microphone shall be an Astatic 611L 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 of 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: Audio amplifier and equipment shall be protected from transient surges on speaker and microphone lines. Protected terminal blocks shall be used for all copper cabling going to the outdoor equipment. All protector terminal blocks shall be din rail mountable assembled in manner, which allows for a 19 inch rack mount installation.

2. Protection Terminal Blocks: Protection shall be provided by Transient Protection Design AmpPro series, MCG DLP-25AMP series 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.

M. Spare Parts: Provide 10% spare but not less than quantity of 1 for the following items used for the project

1. Loudspeaker

2. Amplifier

3. Pre-amplifier and I/O modules used

The spare parts shall be identical to the equipment used for the project.

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, BCCF 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 and BCCF.

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 Standard for Local and Metropolitan Area Networks – Port Based Network Access Control

B. International Organization for Standardization (ISO):

1. 9001 Quality Management Systems

C. National Fire Protection Association (NFPA):

1. 70 National Electrical Code

D. Telecommunications Industry Association (TIA):

1. 568 Commercial Building Telecommunications Cabling Standard

E. Payment Card Industry (PCI):

1. PCI Security Standards

F. UL Solutions (UL):

1. 444 Communications Cables

2. 1863 Standard for Communications-Circuit Accessories

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. For new construction or rehabilitation projects, the TVM wide area network shall use JPB owned fiber optic plant for station connectivity to 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 cannot 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 single mode fiber optic cable as shown on Contract Drawings.

6. In the event that the TVM is not equipped with on board fiber optic ports, a managed Ethernet media converter and compact fiber optic patch panel shall then be provided inside the TVM to implement the TVM connectivity over fiber optic cable.

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 pole temporary covers. The Contractor is responsible for their installation.

8. The Clipper Contractor is also responsible for furnishing and installing all remaining station equipment serving CID equipment, such as: junction boxes, all interconnecting conduits and comm/power wiring; and

furnishing, installing, and terminating all necessary 24VDC power supplies in DC cabinets (one power supply per two CID devices), etc.

9. Clipper Card Interface Devices (CIDs) are installed at locations easily accessible by patrons as shown on Contract Drawings.

10. 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).

11. 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.

12. 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 programs the WAN/LAN Connection, CID Router, CER CID Ethernet Switch, DC's CID Ethernet Switches, 24 VDC power supplies, all interconnecting conduits and wiring, 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 pole temporary covers and the associated grounding equipment.

D. Provide TVM LAN field fiber-to-copper media converter/switch and compact fiber optic patch panel as described in Sections 17790 and 17250 and as indicated on Contract Drawings.

E. 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.

F. Provide Simplified Network Management Protocol (SNMP) Management Application and alarm monitoring/management for Caltrain network devices.

G. Furnish, install, and test all TVM Fare Collection software applications from 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 for each TVM or CID 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, 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 6A 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 Supply per the Contract Drawings. Ensure proper grounding and lightning/surge protection for all TVM and CID equipment installations.

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 568 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 Components Industry Association (EIA/ECA):

1. 310 Cabinets, Racks, Panels, and Associated Equipment

B. Federal Communications Commission (FCC):

1. Rules Part 15, Sub-part J – Equipment Authorization Procedures

C. Institute of Electrical and Electronics Engineers (IEEE)

1. 802 Standard for Local and Metropolitan Area Networks Port-Based Network Access Control

D. International Organization for Standardization (ISO):

1. 9001 Quality Management Systems

E. Military Standards (MIL-STD)

1. 454 Standard General Requirements for Electronic Equipment

2. 810H Environmental Engineering Considerations and Laboratory Tests

F. National Fire Protection Association (NFPA):

1. 70 National Electrical Code (NEC)

2. 731 Standard for the Installation of Premises Security Systems

G. National Electrical Manufacturers Association (NEMA)

H. National Electrical Contractors Association (NECA)

1. 1 Standard for Good Workmanship in Electrical Construction

I. Department of Homeland Security (DHS)

J. Payment Card Industry (PCI):

1. PCI Security Standards

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 6A) or fiber optic cable and raceway.

E. CCTV cameras requiring Power over Ethernet (PoE) shall utilize Cat 6A 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 (variable 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, CCF, and BCCF 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.

14. Image and data transfer using the specified network communication media.

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. Scalable, reliable, manageable and robust system.

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 detail); the remaining areas typically require at least 20 pixels per foot (general level of detail).

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 fallback procedures (in case something goes wrong). Proceed with the installation only after the Engineer approval of installation submittal.

G. Submit bandwidth calculations for the CCTV system based on camera configuration and settings. Also, submit storage calculations in accordance with PCI standards.

H. 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.

I. 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 as built CCTV System coverage areas, the station CCTV equipment final LAN/WAN and Software configuration settings.

J. 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, 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. 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 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.

5. 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.

6. The back box shall provide both input and output alarm trigger connections.

7. The camera unit shall have a pivoting arm to allow the product to be wall, ceiling, or parapet mounted without requiring any additional hardware.

8. The camera housing shall be 360 deg adjustable in the pan direction and 180 deg in the tilt direction.

9. The camera shall be vandal and tamper-resistant.

10. 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

11. 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.

12. 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:

1. The camera shall 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 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:

1) FCC, Class A part 15

2) EN 55022:1998 with A1:2000, A2:2003; Class A

3) CISPR 22: 1997 with A1:2000, A2:2002; Class A

b. Immunity:

1) EN 55024:1998 with A1:2001, A2:2003

2) CISPR 24:1997 with A1:2001, A2:2002

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 Vicon Roughneck V2100B Series 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 ½-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 individually 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:

1. The camera shall 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/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:

1) FCC, class A part 15

2) CISPR 22: EN 55022 EMC Standard

b. Immunity:

1) EN 55024 CISPR 24 Information technology equipment-Immunity characteristics-Limits and methods of measurements

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 Vicon Roughneck V2100D series 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 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 6 and/or Category 6A 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 Bosch Autodome IP Starlight 7000I series or Caltrain approved equal.

2. The Industrial Mini Media Converter shall be Transition Networks model M/E-ISW series or Caltrain approved equal.

2.05 CABLING

A. Furnish and install a UTP Category 6A, 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).

10. 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:

1) Windows Latest version

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: Window Server latest edition

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 them 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 through 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 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 CCTV Head End via the low bandwidth (partial T1) WAN links to the stations, or Caltrain owned fiber optic plant.

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).

F. Spare Parts:

Provide 10% spare but not less than quantity of 1 for the following items as installed for the project:

1. IP fixed camera with mounting hardware assembly

2. IP Dome camera with mounting hardware assembly

3. IP PTZ camera with mounting hardware assembly

4. Power Supplies

5. Media converters

The spare parts shall be identical to items used for the project.

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 6A 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 6A 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 shall be 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 6A, 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 6A.

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 stars 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

SECTION 18000

GENERAL SIGNAL REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes general procedures and requirements for the planning, manufacturing, installation, removal, relocation, modification, testing, placing in service, and documentation of as-built conditions of the various signal systems.

1.02 GENERAL

A. Provisions of this Section apply to all Sections of Division 18, Signals.

B. Modify existing equipment and material as shown on the Contract Drawings to interface with the existing and proposed signal system.

1.03 REFERENCE STANDARDS

A. Electrical equipment, unless specifically excluded herein, shall conform to the standards of the National Electrical Manufacturers Association (NEMA), The Underwriters' Laboratories Inc., (UL), the Electrical Testing Laboratories (ETL), the National Electrical Testing Association, Inc. (NETA), or the Electronic Industries Association (EIA), wherever applicable. Unless specifically excluded herein, materials and workmanship shall conform to the requirements of the National Electrical Code; California Administrative Code, Title 8, Chapter 4, Subchapter 5, Electrical Safety Orders; Caltrain Signal Standards, and any applicable local ordinances.

B. The following General Orders (G.O.) of the State of California Public Utilities Commission (CPUC) shall apply:

1.	26-D	Clearances on Railroads and Street Railroads as to Side and Overhead Structures, Parallel Tracks and Crossings
2.	52	Construction and Operation of Power and Communication Lines for the Prevention or Mitigation of Inductive Interference
3.	75-D	Regulations Governing Standards for Warning Devices for At-Grade Highway-Rail Crossings
4.	88-B	Rules for Altering Public Highway-Rail Crossings
5.	118-A	Construction, Reconstruction and Maintenance of Walkways and Control, of Vegetation Adjacent to Railroad Tracks
6.	128	Construction of Underground Electric Supply and Communication Systems

7. 164-E Rules and Regulations Governing State Safety Oversight of Rail Fixed Guideway Systems

C. The following parts of the Code of Federal Regulations, Title 49, Transportation, Federal Railroad Administration, shall apply:

1. Part 212 State Safety Participation Regulations
2. Part 214 Railroad Workplace Safety
3. Part 219 Control of Alcohol and Drug Use
4. Part 218 Railroad Operating Practices
5. Part 220 Railroad Communications
6. Part 228 Passenger Train Employee Hours of Service; Recordkeeping and Reporting; Sleeping Quarters
7. Part 234 Grade Crossing Safety
8. Part 235 Instructions Governing Applications for Approval of a Discontinuance or Material Modification of a Signal System or Relief from the Requirements of Part 236
9. Part 236 Rules, Standards, and Instructions Governing the Installation, Inspection, Maintenance, and Repair of Signal and Train Control Systems, Devices, and Appliances

In addition, the Contractor shall be responsible for adherence to all of the above rules and reporting requirements, including those regulations which require pre-employment drug testing and random drug testing of employees engaged in the installation and testing of signal facilities, and the reporting and tracking of employees injured in the performance of work on a railroad.

D. Manual on Uniform Traffic Control Devices (MUTCD)

1. Part 8 Traffic Control for Railroad and Light Rail Transit Grade Crossings

E. In addition to the regulations and code requirements specified in this Section, materials and equipment for the signaling systems shall conform to the standards and recommendations of the Communications and Signals Manual of Recommended Practices of the American Railway Engineering and Maintenance of Way Association (AREMA), hereinafter referred to as the AREMA C&S Manual, except that where the Manual uses the word "should" the Contractor shall substitute the word "shall".

1.04 SYSTEM DESCRIPTION

A. Owner-furnished materials for signal systems, if provided, along with delivery points or location of this material for pickup, are listed in the attachments to

Section 01600, Materials. Refer to Section 01600, Materials, for Contractor responsibilities for receiving, accepting, and transporting Owner-furnished materials. Assemble and install this material as shown on the Contract Drawings.

B. Provide all additional materials and installation services required for complete working signal systems, as described herein, and as shown on the Contract Drawings, including any equipment not designated as being relocated or designated as Owner-furnished.

C. All materials and equipment for installation and for interconnection of the various signaling systems shall be fabricated, furnished, and installed as indicated on the Contract Drawings and specified herein.

D. The Contract Drawings represent a final design utilizing systems, components, and materials that meet the Contract Specifications. Contractor may provide equivalent systems, components, and materials subject to the approval of the Engineer. If equivalent systems, components and materials are provided, the Contractor shall provide an alternate detailed final design as specified herein under Design Submittals.

E. Provide systems that are compliant with applicable rules and regulations of 49CFR, Parts 234, 235, and 236, and CPUC GO 75D. Refer to Design Submittals herein for Contractor's responsibility to indicate any corrections or modifications to the Contract Drawings final design that the Contractor may determine are required to conform to these rules and regulations.

F. The Contractor shall be represented at all design meetings held with the Engineer by a signal engineer qualified in the design and application of the signaling equipment the Contractor proposes for use on this project.

G. No circuit is considered to have met the requirement of these Specifications for function and safety until it has been properly tested and verified in the field. Any circuit changes made to meet the functional and safety requirements of these Specifications shall be considered as included as part of the Work.

H. Provide continuous train control and highway grade crossing warning during all phases of rail construction. At no time shall the work of the Contractor cause delay to train operations, create an unsafe signaling condition to exist, or reduce the effectiveness or quality of the existing or new grade crossing warning systems.

1. Refer to Design Submittals herein for requirements for submittal of plans for providing wayside signaling and highway crossing warning systems protection during the Work and plans for point protection and fouling when crossovers are installed or removed. Alternate methods shall conform to CFR 49, Part 234, Part 236 and all local ordinances.

I. Provide rail bonding for all new, temporary, and relocated turnouts as shown on the Contract Drawings or as required by the Engineer. Provide rail bonding, as necessary, to maintain existing systems during construction.

J. Protect existing signal cabling and, where necessary, relocate existing cabling in order to prevent damage during track installation and surfacing.

K. Refer to Section 01720, Contract Record Documents, and additional requirements specified herein. Record the final as-built conditions of the signal systems for each system.

L. Perform and document electronically all tests and inspections in accordance with CFR 49 regulations, the AREMA C&S Manual, the PCJPB Maintenance and Test Manual, and these Specifications.

M. Refer to Section 01005, Contractor's Personnel and Equipment, and additional requirements specified herein. Provide at least one qualified signal person to accompany any on track equipment, and remove, relocate, or disconnect and reconnect any signal equipment that could be damaged by on track equipment. After reconnection, perform all appropriate requirements of 49 CFR 234 or 236.

N. Coordinate installation, inspection, and testing of new Owner-furnished material with the Engineer. Notify the Engineer in writing 30 days prior to any installation, inspection, and testing as part of this coordination.

O. Perform acceptance testing and commissioning of the signal system as a normal part of the Work.

P. Contractor furnished hardware and software shall be new and manufacturer certified.

Q. Remove, salvage, retire, relocate, furnish, and install project related devices as indicated in the Contract Documents and as required to complete the Work.

1. To retire a signal location, first establish protection with operations, bulletin it as retired and then take temporary measures with the existing equipment, as required, before removing and salvaging it.

R. Refer to Section 02300, Earthwork, for provisions for excavation and requirements for shoring of excavation as specified in Section 02200, Support of Excavation.

S. Refer to Section 01047, Utilities and Systems Coordination, for requirements for locating and protecting existing utilities. Details of signal cable runs, conduit runs, and pullbox installations including number, size, and type of cable are shown in the signal drawings of the Contract Drawings. Information regarding new conduit runs and pullbox installations appear elsewhere in the Contract Drawings. Conduit runs and pullbox locations, as shown, are the preferred locations. In case of conflict between the signal drawings and other Contract Drawings, the signal drawings take precedence as to detail, and in the event of conflict as to placement of equipment, the Engineer will determine the correct placement.

1. Make any minor deviations in location, minor meaning within 10 feet of the location as shown on the civil drawings of the Contract Drawings, as part of the Work. Deviations in excess of 10 feet may be subject to the changes provisions of General Conditions GC4, Scope of Work.

T. All underground signal cables shall be in conduit or trough except for the final connection of the twisted two conductor number six track cable spliced to bondstrand connected to the rail.

1.05 FAIL-SAFE DESIGN REQUIREMENTS

A. As used in these specifications, the fail-safe principle shall mean that whenever an equipment failure, human error or failure to act, or adverse environmental condition affects the specified operation of a system involved with the safety of life or property, that system shall revert to a state known to be safe.

B. Failure of a circuit or equipment that results in an indication of a dangerous or restrictive condition, whether or not there is in fact actual danger, shall have met the fail-safe requirements. Conversely, a failure that results in an indication of safe or nonrestrictive condition when, in fact, a dangerous condition may exist shall not have met the fail-safe requirements.

C. Vital applications, such as detector locking of switches, shall be based on the following principles that permit the attainment of fail-safe operation in all known or discovered failure modes:

1. Closed Loops: Fail-safe circuits shall employ the closed loop principle and shall protect against open circuits, shorts, or any combination thereof.

2. Vital Relays: Relays used in vital circuits

3. Vital Circuits: All line circuits, which energize a vital relay, shall be two-wire, double-break circuits and shall be energized from an ungrounded direct current (dc) power supply line circuits are defined as any circuit that leaves the housing in which the relay or microprocessor input is controlled by that circuit from the relay or microprocessor input to the energy that controls that input.

4. Grounds: Components or wires becoming grounded shall not cause an unsafe condition.

5. Spurious Oscillations: Any amplifier, generator, or device element, active or passive, breaking into spurious oscillations shall not cause an unsafe condition.

6. Filters: Filters used in fail-safe circuits shall be designed to prevent undesired signals from appearing at the filter output at levels which could cause an unsafe condition.

D. Equipment failures and conditions which shall be considered in producing a fail-safe design shall include the following, at minimum:

1. Relays (non-vital): Open coil, fused contacts, high contact resistance, shorted coil, armature sticking, contacts sticking, or broken spring

2. Relay (vital as defined by the AREMA C&S Manual): Open coil, shorted coil, or high contact resistance

3. Transformers: Open primary, open secondary, shorted turns, primary-to-secondary shorts, or combinations thereof

4. Capacitors: Short, open, or leakage

5. Resistors: Increase or decrease in resistance

6. Transistors: Short, open, leakage, or loss of Beta

7. Diodes: Short, open, or reverse leakage

8. Coils: Open or shorted turns

9. Loss or degradation of power sources

10. Appearance of abnormal signal levels, electrical noise levels, frequencies, and delays

11. Effects of electrical interference

12. Absent or abnormal input signals

13. Opens or shorts in internal circuitry at inputs and at outputs

14. Mechanical vibration or shock

15. Drift or instability of amplifiers, receivers, transmitters, oscillators, switching circuits, and power supplies

16. Deterioration of contacts, connectors, terminals, solder connections, printed circuits, circuit adjusting devices, and mechanical devices

E. Fail-safe equipment proposed for vital signaling applications shall have been proven with a minimum of 5 years of successful rail service operation in the United States of America.

1.06 ENVIRONMENTAL PARAMETERS FOR EQUIPMENT

A. Contractor provided material and equipment shall be fully operable with no impairment resulting from the effect of the environment throughout the range of worst values indicated below. The general operating environment shall be considered to be in salty atmosphere and in generally sunny weather.

B. Ambient outdoor temperature range: From minus 40 degrees F (minus 40 degrees C) to plus 160 degrees F (70 degrees C).

C. Relative humidity range: From zero to 100 percent.

D. Maximum rainfall: 4 inches in 24 hours and 1.5 inches in 1 hour.

E. Maximum wind velocity: 100 miles per hour.

F. Seismic Zone Location of Work Site: Seismic Zone 4 as defined in the Uniform Building Code.

G. Isokeraunic Level: Five per year.

1.07 DESIGN SUBMITTALS

A. Undertake no work without the prior submittal to and approval by the Engineer of the relevant plans and procedures.

B. Alternate Detailed Final Design: Submit proposed equivalent systems, components, and materials, if proposed, for Engineer's approval no later than 90 days after Notice to Proceed. Utilize, at a minimum, the symbols, nomenclature, and CADD standards depicted on the Contract Drawings and PCJPB Communications/Signal Design Standards. The Contractor's alternate final design drawings shall be approved and stamped by a professional electrical engineer registered in California. The Engineer will render a decision concerning alternative design within 60 days of the Contractor submittal.

C. Submit marked-up Contract Drawings for approval, indicating any corrections or modifications to the final design that the Contractor may determine are required to conform to rules and regulations. Submit these revised drawings for the Engineer's approval within 60 days after Notice to Proceed.

D. Submit proposed plans, procedures, data sheets of proposed materials, application logic, installation details, shop drawings, mechanical drawings, proofs of compliance with applicable standards, and other pertinent data required to fully demonstrate the Contractor's proposed plan for the manufacture, installation, testing, and maintenance of the various signaling systems. Submit for Engineer's approval within 60 days after Notice to Proceed. Plans shall include:

1. Proposed plan for providing alternate methods of wayside signaling and highway crossing warning systems protection when signal components are relocated, deactivated, altered, or modified in order to accommodate construction work.

2. Plan for point protection and fouling when crossover or turnouts are installed or removed.

E. Signal system shop drawings and design submittals shall include any CADD files in MicroStation format. Signal circuit drawings shall conform to the PCJPB CADD standards. Submit electronic files on USB media or via FTP.

F. As part of the Site Specific Work Plan (SSWP) submission for review and approval by the Engineer, prepare and submit a detailed Signaling Construction Sequencing Plan for each location where a signal system is to be modified, installed, or removed. The Plan, as a minimum, shall contain a wire-by-wire for each wire to be disconnected and/or connected, and the following:

1. A narrative description of the work to be undertaken at the designated location.

2. A step-by-step sequence of work description which identifies those steps during which the existing system will be disabled, and a description of what steps will be taken to assure that the signal system will be tested and returned to full operation without causing a delay to any train movement.

3. An estimate of time to complete the critical steps in the sequence specified in step-by-step sequence of work description.

G. Submit circuit drawings indicating any required modifications to new systems or existing circuits where only a segment of the new work can be completed or the complete system must be placed in operation in phases. Submit these temporary interface drawings for the Engineer's approval a minimum of 30 days prior to the scheduled cutover.

1. Revisions to existing circuit plans shall use the "Xs" and "Os" convention to show changes. Encircling the change with "Xs" shall identify deletions. Encircling the change with "Os" shall identify additions. The Contractor may, with the prior approval of the Engineer, alternately use the "Red In"/"Yellow Out" convention.

H. Request approval from the Engineer prior to making any deviation, modification, or changes to the approved design drawings. During the field testing/cut-over period, obtain the approval of the Engineer's representative on site for any deviations, changes, or modification to the design drawings.

1.08 SUBMITTALS

A. Submit product information, references, shop drawings, and test data as detailed.

1.09 DELIVERABLES

A. Submit manufacturers' warranties, instruction sheets, and part lists supplied with materials to the Engineer prior to Final Acceptance.

B. Operation and Maintenance Manuals: A minimum of 30 days prior to placing any system in-service, submit to the Engineer 10 sets of application, installation, operating, and maintenance manuals of all new equipment and systems utilized under this Contract which are provided by the Contractor. Include complete material ordering reference numbers for each type of product.

1.10 QUALIFICATIONS AND DUTIES OF SIGNALING PERSONNEL

A. Refer to Section 01005, Contractor's Personnel and Equipment. Key employees of the Contractor engaged in the final adjustment and testing of the various signaling systems shall be qualified and have had experience on an operating railroad in the type and level of signal installation and testing work as required herein.

B. Signal Engineer as used herein shall be understood to mean Contractor's railroad signal engineer or engineers approved by the Engineer. Signal Manager as used

herein shall be understood to mean Contractor's railroad signal manager or managers approved by the Engineer.

C. Signal construction and installation personnel shall work under the authority of the Signal Engineer. The Contractor's signaling construction forces shall work under the authority of a Signal Engineer.

1. Signal Engineer shall plan, direct, and oversee the adjustment, installation, and testing of signal related work and shall coordinate signal work with related track construction work.

2. Signal Engineer shall be responsible for all work under his charge and must have the authority to remove any personnel from the project who are not performing the work in a satisfactory manner.

3. Signal Engineer shall be on site whenever signal related work or track construction work is in progress in the vicinity of existing wayside signaling equipment, highway grade crossings, and/or cabling.

D. The Signal Managers shall report to and work under the direct authority of the Signal Engineer and shall supervise and direct the work of all signal construction and installation personnel. The Signal Managers shall only perform major and critical activities, such as cutovers under the direct supervision of the Signal Engineer.

E. Signal Engineer shall direct and organize the performance of all tests on signaling equipment and systems, under direction of the Engineer, prior to releasing the systems for service. The Signal Engineer shall be responsible to ensure that all applicable test documentation other than that documentation provided by the Engineer, is completed prior to, or immediately after, in-service testing is completed.

F. The proposed Signal Engineer shall demonstrate experience in the philosophy, application, and testing requirements of the various signaling systems. The proposed Signal Engineer shall have a minimum of 10 years signal supervisory or management related experience on a Class I railroad or approved equivalent. The proposed Signal Engineer shall also demonstrate knowledge of the governing General Code of Operating Rules, including CPUC and FRA regulations and procedures. This demonstration shall be by interview of the proposed Signal Engineer by the Engineer prior to commencement of any work that may affect the signal system. The work of this project includes working within tight windows on a live railroad consisting of freight trains, inter-city passenger trains, and PCJPB commuter trains. Candidate shall have a similar level of working experience to Caltrain system. The Engineer's decision concerning the candidate's qualifications will be final. Begin no signaling related work prior to obtaining Engineer's approval of the Signal Engineer. In addition, obtain the Engineer approval of each Signal Engineer prior to beginning any work that may affect the signal system. Obtain approval of and provide additional Signal Engineers as required depending upon the level and type of work being performed. Propose alternate personnel if the original candidate is found unacceptable.

G. The proposed Signal Managers shall demonstrate experience in the philosophy, application, and testing requirements of the various signaling systems. The proposed Signal Managers shall have a minimum of 3 years signal supervisory or management related experience on a Class I railroad or approved equivalent. The proposed Signal Managers shall also demonstrate knowledge of the governing General Code of Operating Rules, including CPUC and FRA regulations and procedures. This demonstration shall be by interview of the proposed Railroad Signal Managers by the Engineer prior to commencement of any work that may affect the signal system. The work of this project includes working within tight windows on a live railroad consisting of freight trains, inter-city passenger trains, and PCJPB commuter trains. Candidates shall have a similar level of working experience to Caltrain system. The Engineer's decision concerning the candidate's qualifications will be final. Begin no signaling related work prior to obtaining the Engineer's approval Signal Managers. Obtain approval of and provide additional Signal Managers as required depending upon the level and type of work being performed.

H. Propose alternate personnel if the original candidate is found unacceptable. Previous qualification as a Signal Engineer or Manager on other PCJPB projects does not constitute qualification as a Signal Engineer or Manager for this Contract.

I. The Engineer reserves the right to disqualify any Signal Engineer or Signal Manager at any time during the course of the Work. This right is at the sole discretion of the Engineer and is not subject to protest or appeal.

J. All Contractor field personnel shall receive safety training in accordance with Section 01005, Contractor's Personnel and Equipment, and 01545, Work Site Safety and Security.

1.11 AS-BUILT DOCUMENTATION

A. Refer to Section 01720, Contract Record Documents, for requirements preparation and submittal of Record Documents.

B. The following as-built documentation requirements augment requirements specified in Section 01720, Contract Record Documents. After a location is placed in service, submit as-built documentation as follows:

1. Detailed circuit drawings within 3 working days.

2. Submit as-built corrections electronically to the Engineer within 3 working days.

3. Civil Drawings which show the physical location of all signal apparatus and conduits, both along the tracks and perpendicular to it, and heights of all signal structures within 60 calendar days.

C. Annotate the as-built drawing sets to show all approved circuiting and wiring changes made during installation and testing of the location prior to placing it in service, and any approved changes made after placement in service. Clearly identify all changes on the drawings using the "Red In"/"Yellow Out" convention. Alternatively, revisions to existing circuit plans can use the "Xs" and "Os"

convention to show changes. Encircling the change with “Xs” shall identify deletions. Encircling the change with “Os” shall identify additions. Changes shall be dated and initialed by the Contractor's responsible Signal Engineer. Identify the date that the location was tested and placed in service in the revision block of the drawings.

D. In addition to the as-built drawings provided to the Engineer, one set shall be bound and shall be kept in the instrument enclosure at a location and manner approved by the Engineer. As-built drawings shall be clean and legible. The as-built drawings shall not be removed from the field location after the location is placed in service without the prior written approval of the Engineer.

E. The final as-built drawings shall be 11 inches by 17 inches, unless authorized by the Engineer to substitute another size.

F. Each circuit that continues on another drawing shall be annotated with drawing number and routing information for the continuation of the circuit.

G. The circuit drawings shall show all individual circuits. Typical circuits will not be accepted.

H. The location plans shall show all cable installed with the number of conductors, the size of conductors, the type of cable, termination points of conductors, and the circuit on each conductor. Separate cable plans shall be drawn if cable information cannot be shown in a neat and organized manner on the location plans.

I. The shop drawings shall be detailed equipment drawings for each type of equipment installed.

1.12 TRACK AVAILABILITY REQUIREMENTS

A. General: Refer to Sections 01011, Work Planning, and 01040, Work Hours and Track Access, for track access and related provisions. PCJPB Commute Service and any freight service may not be interrupted by the Work of this Contract, except as provided in the Contract Documents.

B. Signal Cutovers may be required under traffic.

C. Signal Cutovers under traffic will require coordination between the Contractor, PCJPB, other railroad, as applicable, and the Operator of Record to keep train delays to a minimum.

1.13 WARRANTY

A. Provide warranties for all equipment and material covering parts and labor for two years from the date equipment or material is "placed in service."

PART 2 – PRODUCTS

2.01 EQUIPMENT – GENERAL

A. Signaling materials and equipment shall be the products of manufacturers regularly engaged in the production of such material and equipment and shall be the manufacturer's latest design. The materials and equipment shall have shown proven performance in the US or Canada for a minimum of 5 years. Materials and equipment shall be delivered to the job-site in unbroken packages, reels, or other forms of containers.

B. All materials and equipment shall conform to the recommendations of AREMA C&S Manual, except as modified in the Specifications and Contract Drawings.

C. Reference to specific equipment and manufacturers is intended to establish quality, overall design, and fit, subject to compliance with all criteria specifications. Equipment equal to or exceeding the specifications and requirements may be used subject to the Engineer's written approval. Should alternate equipment be accepted, the Contractor shall perform all necessary work to fit the alternate equipment to these specifications and to revise the Contract Drawings at no additional cost to the PCJPB.

2.02 ELECTRICAL AND ELECTRONIC COMPONENTS

A. Design and construct fusing of all dc power supplies and circuitry according to the following requirements:

1. Circuit breakers and fuses shall be the correct side-band rating for circuit current interruption and shall protect the electrical equipment and circuits from short-term and long-term overloads.

2. Fuses shall be sized to protect the wire

3. Fuses shall be in the positive leg of the power supply

4. Fuses shall be of the nonrenewable indicating type

5. All branch feeds for a circuit shall be from the same fuse to prevent fuse cascading due to branch fusing carrying loads for other circuits.

6. Fuses shall be no smaller than 5 amperes unless otherwise shown on the Drawings.

7. Loads shall be divided so that no normal operating current is more than 75 percent of the fuse rating.

8. Fusing shall be functionally oriented to minimize the equipment affected by a blown fuse (i.e., per track, switch control circuits, etc.)

9. Fuse clips shall be constructed to retain their resilience under all installation and service conditions and to ensure a positive contact between the clips and the fuse.

B. Printed Circuit (PC) Cards and Connectors:

1. The PC cards shall be mounted in 19-inch card files unless otherwise approved by the Engineer.

2. The PC wiring shall be organized so that wires serving the same function shall be connected to the same terminal of PC cards. PC cards containing the same circuitry and programming, where applicable, shall be interchangeable between subsystems.

3. The design and construction of PC cards of the same subsystems shall be the same. Cards of different subsystems shall be of the same design and construction wherever practicable.

4. PC cards shall be of glass epoxy construction. Card material shall meet the requirements of NEMA, Type FR-4. Cards shall have sufficient thickness to permit easy insertion and removal, and shall be physically keyed to protect against incorrect interchange. Circuits shall be formed by etching. Conductor material shall be copper and shall be protected from exposure to air.

5. PC cards containing components that may be damaged if a plug connector or plug-in unit is removed while the equipment is energized shall be clearly identified in the equipment maintenance manual. PC cards shall be marked or labeled with a warning note on the individual board, be conspicuously located on the module, or by an alternate means as approved by the Engineer. A means shall be provided to remove power from the module or card file.

6. Components mounted on the PC card, weighing more than 1/2 ounce or with a displacement of more than 1/2 cubic inch, shall have a mechanical supporting attachment to the card separate from all electrical connections.

7. Do no stacking or piggybacking of PC sections in order to accomplish changes or modifications to wiring or components on printed circuit cards.

8. Connectors shall have plating with a minimum thickness of 0.00005 inch.

C. Printed Circuit Card Files:

1. There shall be not more than one type of card file for each size of PC card. The card file plug boards shall be registered to agree with the registry of the associated PC card. PC cards shall not project beyond the front of the equipment rack when mounted in the card file.

2. Card files shall be installed in dust-proof cabinets and protected with dust covers.

3. Insulated cable clamping devices shall be located on the back of the file in such a way that wires terminating in the files shall be installed in a neat and secure bundle, rigidly supported, and protected to prevent

chafing of insulation. Cabling provision on the file shall permit wires to enter or leave the file from both the right and left sides. Such cabling shall not restrict access to the card file when the rear covers of the card files are removed.

2.03 SHOP FINISHES

A. Factory finish signal equipment with the exception of signal system parts which are stipulated as field finished in AREMA C&S Manual, Part 1.5.10, and aluminum alloy and galvanized metal components. If manufacturer typically provides factory painted finish for aluminum alloy and galvanized components, include such information in equipment submittals for Engineer's acceptance.

B. Finishes shall comply with AREMA C&S Manual, Part 1.5.10, signal equipment manufacturer's standards, and provisions specified herein. It shall be understood that where AREMA C&S Manual, Part 1.5.10, uses the word "should" that the word "shall" shall be substituted except as accepted by the Engineer in writing.

1. Finish terminal boards and interior of shelters with white gloss fire retardant paint.

2. Factory finish signal equipment with aluminum paint except as otherwise specified herein and in AREMA C&S Manual.

3. For signal system parts which AREMA C&S Manual stipulates as shop primed and field finish, shop prime in accordance with requirements specified in Section 05200, Structural Steel.

4. For signal system parts which AREMA C&S Manual stipulates to receive shop prime and finish coats followed by field finish coat, coordinate shop finish coat with field finish specified in Section 09900, Paints and Coatings.

2.04 FIELD PAINT MATERIALS

A. Field finish as specified in Section 09900, Paints and Coatings, and AREMA C&S Manual, Part 1.5.10. Exterior surfaces shall receive heavy duty finish system.

B. Touch-up Paint for Signal Manufacturer Finishes: Touch-up paints recommended by signal manufacturer, including aluminum touch-up paint.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Contractor shall make all necessary modifications to the existing signal system, protect or relocate existing cabling, signals, switches, and signal shelters; and modify associated signal and highway grade crossing systems to ensure the existing signal system operates as intended during construction and installation of the new signal system. Protect operating signal and highway grade crossing systems to ensure train operations are not interrupted and safety is maintained.

B. Contractor shall take no action which will violate any rule or regulation as specified by CFR 49, the General Code of Operating Rules, timetable instructions, general order, bulletin, or special instruction; which will reduce the integrity of the signal system; or endanger railroad personnel, the public, or employees.

C. All equipment installation as described herein or as shown in the Contract Drawings shall be in accordance with the Caltrain Standards.

D. Ensure that equipment within the instrument shelters and relay cases is securely anchored or otherwise fastened in enclosure upon completion of enclosure installation. Securing equipment shall not negate the requirements to maintain isolation between ground systems as otherwise called for in these Specifications.

E. An updated, detailed set of the approved signal design drawings shall be kept at the each field location for equipment as it is placed in-service.

3.02 FIELD FINISHES AND TOUCH UP

A. For signal system parts which AREMA C&S Manual, Part 1.5.10, stipulates as shop primed and field painted, field finish as specified in Section 09900, Paints and Coatings, and AREMA C&S Manual, Part 1.5.10, including requirement to apply one field coat prior to field assembly and one field coat following field assembly.

B. Touch-up signal manufacturer's finishes after installation.

END OF SECTION

SECTION 18050

COORDINATION WITH PCJPB PROCUREMENT CONTRACTOR

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements coordinating installation, inspection, and testing as well as receiving of new Owner-furnished material or equipment with the Engineer and with the Owner's vendor or supplier. Notify the Engineer in writing a minimum of 30 days prior to any installation, inspection and testing of such material or equipment.

B. Refer to Section 01600, Materials, in the paragraph "Acceptance of Owner-Furnished Materials."

1.02 SUBMITTALS

A. Submit Acceptance Test Procedure documentation on all Owner-furnished equipment prior to transport of the equipment.

1.03 WARRANTY

A. Because the manufacturer's warranty for Owner-furnished material begins upon transfer of custody of the material, supplement the manufacturer's warranty for the amount of time elapsed between acceptance of the material and final cutover and as required under General Conditions GC4.3, Guaranty of Work. The supplemental warranty shall include all costs to repair or replace material which is damaged while in Contractor's care or fails prematurely and as required under GC4.3, Guaranty of Work. Make arrangements for and pay costs of such repairs performed by and replacements provided from the original equipment manufacturer.

PART 2 – PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Test all Owner-furnished equipment before transporting it to the job site. Conduct this acceptance testing for all equipment in accordance with the Contractor's Acceptance Test Procedure. Prior to transportation, submit a copy of the documentation of acceptance testing to the Engineer.

PART 3 - EXECUTION

Not Used.

END OF SECTION

SECTION 18100
INTERLOCKING CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for installing, testing, and documenting pre-wired vital microprocessor based interlocking controller racks and local control panels that provide the functionality shown on the Contract Drawings.

B. Final application logic programs, including EPROMS (where applicable) will be furnished by the Owner.

1.02 REFERENCE STANDARDS

A. Code of Federal Regulations (CFR), Title 49, Subtitle B, Chapter 2:

1. Part 236 Rules, Standards, and Instructions Governing the Installation, Inspection, Maintenance, and Repair of Signal and Train Control Systems, Devices, and Appliances

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

1. Communications and Signals Manual of Recommended Practices (C&S Manual).

1.03 SUBMITTALS

A. Submit a narrative explanation of the electrical and/or mechanical methods of configuration control used to ensure that the application logic software installed is the correct software for the specific location and that it is the latest version. It shall explain Contractor's procedures for handling components of the vital interlocking controller.

B. Submit certified acceptance reports.

C. Submit test reports and verification of tests as described herein under Testing.

1.04 QUALITY ASSURANCE

A. Install and test the interlocking controller and local control panel (LCP) so as to conform to and provide all applicable requirements of CFR 49, Part 236, and the recommendations of AREMA C&S Manual Part 2.2.10. When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package plug in modules for shipment separately from their card cage units using ESD safe packaging. Protect each item from damage or loss during handling and shipment.

B. Clearly identify each controller unit, LCP, and their associated components on the packing crate, referencing its intended location.

1.06 WARRANTY

A. Provide warranty from defects arising from improper handling for 2 years from the first date of service.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Solid State Micro-Processor Interlocking Controller, software, and local control panels will be Owner-furnished.

2.02 FACTORY TESTING

A. Conduct an acceptance test on the unit prior to loading at the warehouse. Provide certified acceptance reports with each unit at time of delivery.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ensure that test and specialized installation equipment recommended by the manufacturer to make any readings or adjustments is in the Contractor's possession and within the project limits a minimum of 30 days prior to installation

3.02 INSTALLATION

A. Wire and install the microprocessor-interlocking controller and the LCP in accordance with rack layout provided in the Contract Drawings.

B. Load all programmable and configurable modules with application software and perform any configuration necessary.

3.03 FIELD QUALITY CONTROL

A. Conduct all applicable tests as recommended in AREMA C&S Manual Parts 2.4.1 and 7.4.1 to ensure proper operation of the signal and grade crossing warning systems.

B. Conduct tests to ensure that the signal system conforms to CFR 49, Part 236.

C. Conduct all tests required under Section 18600, Signal Systems Testing.

D. Testing, including pre-testing, shall include operating all switch machines and lighting all signals. The use of lamp simulators in lieu of, or in parallel with, signal lamps will not be allowed in pre-testing. An exception may be authorized by the Engineer where a signal or switch machine is in service and will be reconfigured for final cutover or cannot be installed or wired until final cutover.

END OF SECTION

SECTION 18110

SOLID-STATE CODED TRACK CIRCUITS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for furnishing, installing, testing, and documenting solid-state track circuit elements.

B. Final application logic programs will be furnished by the Owner.

1.02 REFERENCE STANDARDS

A. Code of Federal Regulations (CFR), Title 49, Subtitle B, Chapter 2:

1. Part 236 Rules, Standards, and Instructions Governing the Installation, Inspection, Maintenance, and Repair of Signal and Train Control Systems, Devices, and Appliances

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

1. Communication and Signals Manual of Recommended Practices (C&S Manual).

1.03 SUBMITTALS

A. Submit a narrative explanation of the electrical and/or mechanical methods of configuration control used to ensure that the application logic software installed is the correct software for the specific location and that it is the latest version. It shall explain Contractor's procedures for handling components of the solid-state track circuit equipment.

B. Submit certified acceptance reports.

C. Submit test reports and verification of tests as described herein under Testing.

1.04 QUALITY ASSURANCE

A. Install and test the solid-state track circuit equipment in accordance with all applicable requirements of CFR 49, Part 236 and the recommendations of the AREMA C&S Manual, Part 8.1.2. When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

B. Perform operational testing of the equipment in accordance with the requirements specified in Section 18600, Signal Systems Testing.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Ship the solid-state modules separately from the wired card cages. Package modules individually in ESD safe packaging, in a sturdy carton with the type of module printed on the outside of the carton.

B. Package plug-in modules for shipment separately from their card cage units using ESD safe packaging. Protect each item from damage or loss during handling and shipment.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Electronic track circuits shall be compatible with highway grade crossing constant warning devices. Utilization of bi-directional, unidirectional, and auxiliary crossing control functions shall be provided per Contract Drawings and manufacturer's specifications. Track filters shall be installed in track leads, as shown on the Contract Drawings.

B. Where new equipment is to be furnished and installed in existing locations, the equipment furnished shall be the same make as called for in the Contract Documents.

C. Track circuit shall function to provide continuous train detection throughout the length of the circuit whenever a shunt of 0.06 ohms is applied to the rails, including the turnouts.

D. Furnish any specialized test or calibration instruments, equipment, or tools that may be needed in order to test and place in-service the equipment installed under this Section, as shown on the Contract Drawings. Ensure all test and diagnostic equipment is in the Contractor’s possession and within the project limits a minimum of 30 days prior to installation.

E. Conduct an acceptance test on Owner-furnished units prior to loading at the warehouse.

F. Conduct acceptance testing of Owner-furnished components before transporting from the warehouse and installing. Provide certified acceptance reports at time of delivery.

2.02 APPLICATION LOGIC

A. The Owner will provide the application logic for each programmable module to the Contractor. Application Logic will be furnished upon demonstration of readiness for pretest. This application logic will provide the functionality as shown in the Contract Drawings and shall conform to CFR 49, Part 236. Where specified in the Contract Documents, the Contractor shall furnish the program specified to the manufacturer for factory testing and certification.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install solid-state coded track circuits at locations indicated on the Contract Drawings.

B. Install the solid-state track circuit equipment in signal instrument shelters or cases as shown on Contract Drawings.

C. The solid-state track circuit equipment layouts shall provide for easy access to test points, indicators, and adjustments.

D. Install equipment in accordance with the manufacturer's installation and adjustment procedures.

3.02 TESTING

A. Conduct tests as recommended in AREMA C&S Manual Parts 2.4.1, 3.3.1, and 7.4.1 to ensure proper operation of the signal and grade crossing systems.

B. Conduct tests to ensure that the signal system conforms to CFR 49, Part 236.

C. Conduct all tests required under Section 18600, Signal Systems Testing.

D. Testing, including pre-testing, shall include operating any handthrow switches and lighting all signals. The use of lamp simulators in lieu of, or in parallel with signal lamps will not be allowed in pre-testing.

END OF SECTION

SECTION 18200

SIGNAL LAYOUTS, STRUCTURES AND FOUNDATIONS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section shall include disassembling, relocating and installing existing or new signals.

B. Signal layouts, as specified herein, shall consist of foundations, signal heads and all structures including ground-mounted masts, ladders, platforms, and all mounting hardware required to construct signals.

C. Contractor shall furnish and install signals and marker lights as shown on the Contract Drawings at existing and new signal locations.

1.02 REFERENCE STANDARDS

A. American Railway Engineering and Maintenance-of-Way Association (AREMA)

1. Communications and Signals Manual of Recommended Practices (C&S Manual). When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

1.03 DESIGN REQUIREMENTS

A. Signal Foundation Structure: The Contractor is responsible for the foundation structure type selection and its design. The design of the signal foundation's structure and stability shall be in accordance with the AREMA. Design calculations shall be prepared by a licensed California professional civil engineer with a minimum of 5 years experience in the design of similar foundation structures.

B. Signal aspect shall be distinct and unmistakable when viewed from a height of 7 to 12 feet above top of rail at a distance of 1,000 feet. Nominal sighting distance shall be 2,000 feet. Where unobstructed sighting distance for a standard signal arrangement is less than 2,000 feet, adjust the signal head for the maximum sighting range possible. Contractor shall provide the Engineer with written notification with any sighting problems.

1.04 SUBMITTALS

A. Submit shop drawings for each type of signal unit and each type of signal layout to be furnished by Contractor. Show all ladders, masts, bases, arms, and required mounting hardware. Show location and method of mounting the signals to the structure.

1. Provide necessary dimensions, hardware, method of mounting signal structures, and material specifications for all items to be furnished.

B. Submit shop drawings for each type structure foundation.

C. Submit Contractor's Installation Procedure for approved. The procedure shall include a detailed description of installation activity and sufficient detail to allow the Engineer to determine the validity of the installation procedure.

D. Submit design calculations for the signal cantilever/bridge foundation.

E. Submit design calculations and plans for the signal cantilever/bridge.

1.05 QUALITY ASSURANCE

A. Signals, structures, and related hardware shall meet the recommendations of AREMA C&S Manual, Section 7, and applicable portions of Manual Part 3.2.5 where they do not conflict with any requirements specified herein

B. Inspect each signal layout after it has been installed in the field. This inspection shall conform to the Contractor's Installation Procedure as accepted by the Engineer.

C. Foundations shall meet all recommendations of AREMA C&S Manual Parts 14.4.1.A through 14.4.36 inclusive, where requirements of the AREMA Specifications do not conflict with any requirements specified herein.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Ship signal LEDs separately from the signal in which they will be used.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Furnish LED signals, as indicated in the Contract Documents, and marker light assemblies. Signals and marker light assemblies shall be in accordance with Caltrain Engineering Standards.

B. Furnish signal masts, signal cantilevers and signal bridges, as applicable, in accordance with Caltrain Engineering Standards.

C. Furnish mounting brackets for marker light assemblies, ladders, junction boxes, housings, backgrounds, hoods and any other nuts, bolts, and associated hardware.

D. Furnish foundations for signal masts, signal cantilevers, and signal bridges, as applicable, in accordance with Caltrain Engineering Standards.

2.02 SIGNALS

A. Signal mounting shall conform to the Caltrain Engineering Standards.

B. Signal LEDs shall be products specified in the Contract Documents or equal.

2.03 SIGNAL MASTS

A. Mast assemblies for ground mounting shall conform to the Contract Drawings and Caltrain Engineering Standards.

2.04 SIGNAL BRIDGES AND CANTILEVERS

A. Refer to the Contract Drawings for Signal Bridge and Cantilever requirements.

B. The junction box shall have two terminals with insulated test links, as specified in Section 18360, Signal Systems Miscellaneous Products, for each cable conductor. Provide 10 percent spare terminals. Do not overcrowd terminals.

C. Cable entry to the junction box shall be direct from the signal structure. External conduit construction is not acceptable. Provide an opening approximately four by six inches near the base of the signal structure under each junction box location to allow access for cable sealing at the foundation. Provide bolt-on access plate which will cover the opening under normal conditions.

D. Locate junction box either at the base of a main support mast or on a main support mast at a height of between 3 and 5 feet above the finished grade level at the base.

E. The method of routing cables from the junction box to each signal mounted on the structure shall be to route the cables within the tubular members of the structure to the greatest extent possible. Pull cables entirely through the structure members, mast, and signal mounting brackets, unless otherwise approved by the Engineer. To facilitate this, provide appropriate pull box locations as needed, located a maximum of 5 feet from each signal. Edges shall be smooth and rounded to accommodate cable installation. Provide a means to prevent entry of rodents and insects at the bases of the vertical masts without cable entrances.

1. Use galvanized rigid steel conduit where wire is to be run external to the structural members, except as noted.

2. Use flexible armored conduit to make the connection from the pull box to the individual signal heads.

2.05 SIGNAL FOUNDATIONS

A. Furnish galvanized steel foundations complete with galvanized bolts, washers, nuts, and associated hardware. Galvanizing shall conform to Specifications Section 18360, Signal Systems Miscellaneous Products, and AREMA C&S Manual, Part 15.3.1.

B. Construct galvanized steel foundations of steel angle and plate welded together. Foundations shall be constructed of 2-1/2 inch by 2-1/2 inch by 1/4-inch steel angle and 1/4 inch steel plate.

C. Bolt spacing shall be to manufacturer's standards for the equipment to be supported by the foundation.

D. Concrete Foundations: Cast-in-place in accordance with Section 03300, Cast-in-Place Concrete, or precast concrete as manufactured by Dixie Precast or equal.

PART 3 - EXECUTION

3.01 INSTALLATION - SIGNALS

A. Contractor shall install signal layouts in locations as indicated on the Contract Drawings and as shown on the accepted shop drawings. No part of any signal layout shall conflict with Caltrain Engineering Standards, Code of Federal Regulations, Part 49, or CPUC rules and regulations.

B. Locate signals centered between insulated joints, except where physically not possible. In such instances, Contractor shall submit a recommendation to the Engineer for approval.

C. Center line of signal mast shall be 12 feet 0 inches from centerline of track unless a deviation from this is approved by the Engineer, as shown on the Contract Drawings or required to meet CPUC clearance requirements.

D. Install signal units level and plumb on their foundations. Leveling nuts shall be used as shown on the Caltrain Engineering Standards.

E. Install signal layouts in accordance with the applicable recommendations of AREMA Signal Manual, Part 7.4.1 and Caltrain Engineering Standards.

F. Install platforms for each signal unit level.

G. Align signals for maximum viewing distance before placing in service.

H. Refer to Design Requirements herein regarding signal aspect and sighting distances. Install signals and verify sighting distances. Provide the Engineer with written notification with any sighting problems.

I. Mount signal heads on an offset arm as shown in Caltrain Engineering Standards. Signal heads shall also be able to swivel on the offset arm and be adjustable.

J. Signal nomenclature shall be as shown on the Contract Drawings.

K. The underground cable shall be dressed, potheaded, tagged, and terminated in the signal junction box as specified in Section 18360, Signal Systems Miscellaneous Products. The conductor size of the underground cables shall be at least as large as that shown in the Contract Drawings.

L. Wiring from the junction box base to the signal heads shall be minimum No. 10 AWG copper stranded wire or larger as shown on the Contract Drawings.

M. Install identification tags on each wire. These tags shall bear the nomenclature shown on the accepted Shop Drawings.

N. Install signal cantilevers as shown on Contract Drawings.

3.02 INSTALLATION - SIGNAL BRIDGES AND CANTILEVERS

A. Signal bridges and cantilevers shall be installed as shown on Contract Drawings.

3.03 INSTALLATION - FOUNDATIONS

A. Install each foundation in accordance with the approved Contractor's Installation Procedure for each type of foundation, as herein specified, and as shown on the Contract Drawings. The absence of a specific task listing herein does not relieve the Contractor of the responsibility for providing a complete and functional installation.

B. Refer to Section 01047, Utilities and Systems Coordination, for requirements for locating and protecting existing utilities. Advise the Engineer immediately if any utility or cable interferes with the foundation work. After locating an interference, allow 72 hours for the Engineer to relocate or mitigate the interference.

C. Prior to placing steel foundations in the excavations, place and compact a crushed stone base in accordance with Section 02300, Earthwork.

D. When placing foundations, exercise care and ensure that anchor bolts are not bent or threads damaged. Protect anchor bolt threads, washers, and nuts by applying friction tape or other accepted method satisfactory to the Engineer, until the unit to be supported is installed.

E. After backfilling foundations, ensure that the foundation is plumb and level. Where galvanized steel foundations are installed, top of final grade shall be no more than 24 inches below top of foundation.

F. Install foundations to the lines, grades and dimensions required as determined by the Contractor and accepted by the Engineer. Mounting bolts shall be of sufficient length to accommodate use of leveling nuts between the base of the equipment to be supported and the top of the foundation.

3.04 PAINTING

A. Touch up any damaged painted finish.

3.05 FIELD TESTS

A. Make tests for proper operation and setting of lamp operating voltages in accordance with Section 18600, Signal Systems Testing.

END OF SECTION

SECTION 18300

RELAYS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for relays. Unless indicated as Owner Furnished in Section 01600, Materials, or as relocated on the Contract Drawings, relays shall be Contractor furnished.

1.02 REFERENCE STANDARDS

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

1. Communications and Signals Manual of Recommended Practices (C&S Manual). When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

1.03 SUBMITTALS

A. Contractor shall provide acceptance testing and documentation for each relay when it is transported from the warehouse to the job site.

B. Complete Test Report Form provided by the Engineer for each vital relay installed under this Contract. Use typewritten characters to fill in all information requested on the form.

1.04 QUALITY ASSURANCE

A. Vital relays shall meet the recommendations of AREMA C&S Manual Part 6.2.1, where they do not conflict with any requirements specified herein. Vital Relays shall be of the type as designated in the PCJPB Standard Drawings.

B. Factory testing of each relay shall be the manufacturer's standard.

C. Before any relay is used, obtain the Engineer's written acceptance. Acceptance will be based on the test results and the proper completion of the Test Report Form.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Ship vital relays separately from the wired racks in which they are to be used. Package relays individually; each in a sturdy corrugated cardboard carton with the drawing number of the relay printed on the outside of the carton. Store relays in a protected area until tested and installed.

1.06 SPARE PARTS AND SPECIAL TOOLS

A. Refer to Section 01600, Materials, for details regarding packaging and delivery of spare parts and special tools.

B. Furnish spare relays in the quantities indicated on the Contract Drawings.

C. Furnish one test tool or relay wrench for each shelter where relays are installed.

D. Furnish 12 inserting/extracting tools for each type of contact requiring a special tool.

PART 2 – PRODUCTS

2.01 GENERAL

A. Relays shall be in dustproof enclosures, except a provision shall be made for ventilation where required for heat dissipation.

2.02 VITAL DC RELAYS

A. General:

1. Vital Relays shall be ASO Type B, Siemens Type "ST", or equal. Contractor shall use the specific relays shown on the Contract Drawings.

2. Vital dc relays, unless otherwise indicated on the Contract Drawings, shall be of the plug-in type and rack-mounted. Relays shall have a transparent dust cover made of a nonflammable composition that will not support combustion.

3. Vital Relays, with a nominal operating voltage of 10 to 16 volts, shall be capable of operating continuously without resultant damage, with a minimum voltage range of 7 to 21 volts inclusive, applied to their operating circuits.

4. Vital relays shall have a test terminal to allow convenient measurement of the coil voltage.

5. Design biased neutral vital relays so that gravity alone will prevent the armature from picking up if the permanent magnet is de-energized or if no current is applied to the coil, due to interruption of the normal magnetic circuit.

6. All front contacts shall be silver-to-metal carbon, meeting the recommendations of the AREMA C&S Manual Part 6.2.1.

7. Arc suppression for vital relays shall be built into the relay or into its plugboard.

8. Equip vital plug-in relays, except vital time-element relays and special application relays, with front current testing facilities. Where shown on the Contract Drawings, provide facilities to enable the testing of voltage from the front of the relay, without having to remove the relay or remove adjacent relays.

9. Equip vital relays with a registration plate to prevent relays of the wrong style, contact arrangement, or operating characteristics, from being inserted into the plugboard.

2.03 IDENTIFICATION

A. Facilities shall be included for mounting an approved typed or printed relay nametag for each relay, either on the relay cover or on the relay cabinet front plate, as applicable. The nametag shall be easily replaceable, but shall not come off during normal service.

B. Identification shall be in accordance with Section 18360, Signal Systems Miscellaneous Products.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Ensure that the relay operating characteristics have not been altered due to damage during shipping procedures.

B. Ensure that all ac and dc power buses are open while installing relays. Do not reconnect buses until all relays have been installed.

C. Install and wire the relays as shown on the Contract Drawings.

D. Identify each relay with nametag.

3.02 FIELD QUALITY CONTROL

A. All dc vital relays shall be tested and inspected in accordance with AREMA C&S Manual Part 6.4.1.

B. Perform tests in accordance with Section 18600, Signal Systems Testing.

C. Record test measurements on Test Report Form provided by the Engineer.

END OF SECTION

SECTION 18310
SIGNAL SHELTERS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for new factory-wired equipment shelters and relocating existing equipment shelters.

1.02 REFERENCE STANDARDS

A. Code of Federal Regulations (CFR), Title 49, Subtitle B, Chapter 2:

1. Part 234 Grade Crossing Safety

2. Part 236 Rules, Standards, and Instructions Governing the Installation, Inspection, Maintenance, and Repair of Signal and Train Control Systems, Devices, and Appliances

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

1. Communications and Signals Manual of Recommended Practices (C&S Manual). When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

1.03 SUBMITTALS

A. Submit proposed Installation Test Procedures.

B. Submit load calculations, indicating sizes of load center panel, voltage drops, and all other 240/120 Vac equipment.

C. Submit Contractor's Inspection and Acceptance Procedure.

1.04 QUALITY ASSURANCE

A. The Contractor shall provide documentation of acceptance "in good condition" before removing and transporting existing shelters to the job site.

B. The Contractor shall provide documentation of Factory Acceptance Testing before transporting new shelters to the job site.

C. Each shelter and case will be inspected after they have been installed and the Contractor shall correct any deficiencies. This inspection will be conducted in conformance with the requirements of the Contractor's accepted Inspection and Acceptance Procedure.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Properly fasten and brace equipment shipped within shelters and cases to prevent damage during transit. Replace any equipment damaged during transit or prior to in-service operation at no cost to the Owner.

B. Package all vital relays, batteries, and electronic plug-in modules in separate containers for shipment and do not install until the shelter is set at its final location.

PART 2 – PRODUCTS

2.01 GENERAL

A. Furnish factory-wired equipment shelters or junction cases, as described herein and as shown on the Contract Drawings. These shelters shall be complete with all the equipment shown on the Contract Drawings. Wiring shall conform to NEMA Standard ICS-70, or National Electrical Code (NEC), and the recommendations of the AREMA C&S Manual, as applicable.

B. Equipment shelters shall be products manufactured by P.T.M.W., Siemens, ASO or equal.

C. Equipment shelters shall be the size and layout shown on the Contract Drawings.

D. Equipment shelters shall be rain-tight and dust-tight, National Electrical Manufacturers Association (NEMA) 3R, ventilated, and have hinged doors with three point latch and handle.

E. Equipment shelters shall be constructed of 12-gauge galvanneal steel for floors, walls, and doors. Roofs shall be no less than 14-gauge galvanneal steel with a minimum of 50 lb/ft^2 loading.

F. The entire structure shall be powder coated on the outside with TGIC Polyester Powder (or equal polyester powder) with a nominal thickness of four mils, but no less than three mils at any point on the surface of the enclosure in accordance with AREMA C&S Manual Part 1.5.10. The exterior color shall be light gray.

G. The steel instrument enclosures shall be complete with moveable shelves, wire chase, and backboard.

H. The equipment shelters shall provide access to underground and aerial cable entrance behind the main terminal rack. The top and sides shall be lined with heat and cold insulating material and constructed to prevent sweating. Provide ventilation openings as required for the size of the shelter proposed. No ventilation opening shall be made in the roof of the shelter. Provide lift rings to facilitate the movement of the shelter.

I. Provide ventilation openings in each door. The exterior of the ventilation openings shall be hooded to minimize the entrance of precipitation. Equip the interior of ventilation opening with sliding plate to allow the adjustment of airflow and with a replaceable dust filter. The doors shall be hinged and gasketed so that they will provide a dust proof and weatherproof seal. Provide doors with exterior and interior handles, (interior handles not required on cases) welded to a three point

locking device to ensure that the door cannot be locked until it is in the fully closed position. Provide doors with a two-position retaining device to secure the door when open.

J. Door openings shall be 32 inches wide by 86 inches tall unless otherwise specified on the Contract Drawings.

K. Provide thermostatically controlled exhaust fans, operated from 120 Vac and fused separately, in each shelter, as shown on the Contract Drawings. The thermostat that activates the fan control shall be adjustable and operate in the range of 70 degrees to 130 degrees Fahrenheit. Locate fans relative to the fresh air inlets to draw air over the equipment and size to renew the air within the shelter every 3 minutes. Exhaust fans shall have removable dust filters. Dust filters shall be either replaceable or cleanable.

L. Hinges shall be separate castings, securely fastened to the shelter and door. The hinges shall be equipped with bronze hinge pins, shall be lubricated by the manufacturer before the case is shipped, and shall have grease fittings for later lubrication.

M. Furnish equipment shelters with interior LED lighting and duplex 120 Vac power receptacles. Equip shelters and cases with LED lights, as required to provide complete illumination for all passages and sides, and operated from a switch conveniently placed near each entrance door. Furnish convenience outlets as part of each switch.

N. Shelter lighting and receptacle loads shall be fed from a ground fault interrupt circuit breaker used exclusively for these loads. Signaling logic and signal appliance power loads shall be fed from separate circuit breakers. The signal logic power and signal appliance power shall be ungrounded. The Contractor shall size circuit breakers and wiring.

O. Furnish shelters complete with a 120/240 Vac power distribution panel, circuit protective devices, and all appurtenances necessary to supply the ac power required at each site.

P. Furnish shelters complete with HVAC equipment to maintain the air temperature within the enclosure between 50 and 86 degrees Fahrenheit. To size the HVAC, assume that the heat load is a minimum of 2 times the heat output of the equipment in the enclosure.

Q. Furnish shelters complete with an external 240VAC plug/receptacle for portable generator connection.

2.02 EQUIPMENT MOUNTING

A. General:

1. Mount equipment as shown in the Contract Drawings.

2. Mount all equipment in such a manner that a seismic event within the parameters of Section 18000, General Signal Requirements, will not cause damage or excessive motion.

B. Relay Plugboards:

1. Design plugboards for insertion of removable type contacts. The method of attaching the wires to the removable contacts shall be solderless connections. Design plugboard so that the removable contact will have a direct connection with the contact and coil prongs. The plugboards shall be in accordance with applicable sections of AREMA C&S Manual, Part 6.2.1.

2. All wires shall be of sufficient length to permit them to be moved to any contact on the same relay.

3. Equip the plugboards for vital relays with a registration plate to prevent relays of the wrong type, contact arrangement, or operating characteristics from being inserted.

2.03 IDENTIFICATION

A. Stencil a white identification number at the top of the front and rear frames of each rack or panel.

B. There shall be an identifying nameplate for each relay, or other instrument mounted on the rack or panel.

C. Equip the back and front of the relay plugboards with a tag, as specified in Section 18360, Signal Systems Miscellaneous Products. This tag shall indicate the nomenclature of the relay.

D. Identify terminals and both ends of all wires with a wraparound tag printed with the circuit nomenclatures and terminal designations as shown on the Contract Drawings and as specified in Section 18360, Signal Systems Miscellaneous Products.

E. Wire and cable conductor identification tags for terminal board mounting shall be as specified in Section 18360, Signal Systems Miscellaneous Products.

2.04 CABLE ENTRANCE TERMINAL BOARDS

A. Cable Entrance Terminal Boards shall be 3/4-inch Type AB exterior (five ply) plywood, mounted on a rack and painted with a fire retarding paint.

B. Cable Entrance Terminal Boards shall be located as shown on the Contract Drawings.

C. Multiple-unit terminal blocks for wire and cable conductors shall be in accordance with AREMA C&S Drawing 14.1.6. Furnish each binding post with two binding nuts, one clamp nut, and three washers.

D. Provide Invensys Rail or equal test links on all terminal pairs where conductors enter shelters.

E. Equip binding posts and exposed terminals of other apparatus for circuits exceeding 50 volts or greater (ac or dc) with insulating nuts and sleeves.

F. Cable entrance facilities shall be located as shown on the Contract Drawings.

G. Lightning arresters shall be as specified in Section 18360, Signal Systems Miscellaneous Products.

2.05 CABLE ENTRANCE PIPES

A. Cable entrance pipes shall be supplied by Contractor as specified in Section 18360, Signal Systems Miscellaneous Products.

2.06 GROUNDING

A. Shelter shall be fitted with four 36-inch long No. 2 ground wires cadwelded to exterior of the shelter at each corner. Cadwelding shall take place prior to powder coating the structure.

B. Grounding material shall be supplied by Contractor and installed as specified in Section 18450, Grounding.

2.07 INTERNAL WIRING

A. Internal wiring shall be in accordance with Section 18370, Signal Wire and Cable.

B. Minimum wire conductor sizes shall be as shown on the Contract Drawings unless otherwise approved by the Engineer.

C. Adhering to minimum wire size specifications does not relieve the Contractor's responsibility of using wire sized large enough to safely and effectively provide power to the circuit it serves.

D. Solderless terminals, for stranded wire, shall be in accordance with Section 18360, Signal Systems Miscellaneous Products.

E. Solid terminal connectors shall be used for all short terminal jumpers.

F. Wire shall conform to the requirements in Section 18370, Signal Wire and Cable.

2.08 PAINTING - INSULATION

A. All instrument enclosures shall be furnished complete with a layer of rigid insulation on the walls, doors, and ceiling. Instrument shelters shall have a minimum 2-inch thick layer of rigid closed cell foam insulation rated R13. Instrument cases shall have a minimum 1/2-inch thick layer of rigid closed cell foam insulation rated R3.3. Insulation shall be suitable for residential installation.

B. The interior including the ceiling, walls, terminal boards, and shelves shall be finished with a primer and two coats of white latex enamel paint.

C. All paint shall be fire-retarding type.

D. Contractor shall apply typical legend for control point shelters, highway grade crossing shelters and cases as indicated on Caltrain Standard Drawings (SD-5000 series). Contractor shall consult with manufacturer of shelter prior to paint application.

2.09 EQUIPMENT RACKS

A. Equipment racks shall be the manufacturer's standard for the type of equipment furnished and shall be sized in conformance to the Contract Drawings.

B. Equipment racks shall include all necessary supports for wire and equipment.

C. Secure equipment racks by bolts attached to a threaded mounting plate structurally secured to the floor of the shelter. Attach stabilizing straps to the top of the racks as needed. Racks and mounting shall be secure enough to withstand a seismic event as specified in Section 18000, General Signal Requirements.

2.10 OTHER EQUIPMENT

A. Wiring Raceway (Wire Routing): Internal case wiring shall be contained within surface-mounted plastic raceway. Raceway shall be of a polycarbonate, low smoke type with a solid snap-on cover and flexible sidewalls. The sidewalls shall be of "finger" type construction allowing for insertion and removal of wire runs with terminations attached. The manufacturer shall determine sizes. Fill capacity shall not exceed 60 percent.

B. Panel Board: Furnish a single-phase, three-wire 120/240 VAC, 60 Hz panel board for each shelter furnished under this Contract. Size panel board as shown on the Contract Drawings. The capacity rating shall be in accordance with the Contractor's load calculations and the Contract Drawings.

C. Service meters shall conform to local codes.

2.11 GALVANIZED SHELTER FOUNDATIONS

A. All shelters shall be equipped with telescoping foundations complete with galvanized bolts, washers, nuts, and associated hardware. Galvanizing shall conform to Section 18360, Signal Systems Miscellaneous Products, and AREMA C&S Manual, Part 15.3.1.

B. Galvanized steel foundations for cases shall be constructed of steel angle and plate welded together. Foundations shall be constructed of 2-1/2 inch by 2-1/2 inch by 1/4-inch steel angle and 1/4-inch steel plate.

C. Bolt spacing shall be to manufacturer's standards for the equipment to be supported by the foundation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Mount shelters and cases level and plumb and secure thereon with the hardware provided. Do not use shims, spacers, or other filler devices to level and plumb shelters or cases.

B. Install cable entrance pipes through the cable knockout holes provided in the floor of the shelter behind the terminal board(s) as shown on Contract Drawings. Fill

pipes with a substance designed for the purpose that prevents entrance of debris, rodents, and other pests.

C. Ground shelters as specified in Section 18450, Signal Grounding.

D. Locate shelter as indicated on the Contract Drawings. If conditions do not allow placement as shown on the Contract Drawings, submit alternate placement for Engineer's approval. Signal shelters shall be installed at least 25 feet from centerline of track.

E. Install relays on the relay plugboards corresponding to the relay nomenclature and identification plate, and securely fasten in place with the hardware provided by the relay manufacturer.

F. Place batteries on rubber matting on the floor of the house or bottom shelf of the case. Coat battery posts with approved grease and securely fasten battery connectors to the battery posts. Strap batteries or otherwise secure using a method approved by the manufacturer so that they will not tip or move in the event of an earthquake.

G. Mark each grade crossing warning device case or shelter with the street name, milepost location, emergency response number, and DOT inventory number per PCJPB Standards.

H. Install pullboxes and conduits. Provide slotted pullbox covers to accommodate the cable chute at new house locations. Place the house so the chute aligns with the slotted cover.

I. Make any modifications to the cable chute required to fit the pullbox and accommodate the cable installation. If it is necessary to cut the cable chute, ensure no rough edges, sharp edges, burrs, or other surfaces exist which have the potential to injure the cable.

J. Install foundations, including telescoping foundations, for shelters including Owner-furnished shelters.

3.02 AC POWER

A. Wall mount load center as shown on the Contract Drawings. Mounting height from floor, wire terminations, and clearances shall be in accordance with the NEC.

B. Install service meters as described in Section 18500, Service Meters.

3.03 FIELD QUALITY CONTROL

A. Test the functioning of the equipment contained within the instrument shelter in accordance with the requirements of Section 18600, Signal Systems Testing, CFR Title 49, Parts 234 and 236, and the recommendations of AREMA C&S Manual Part 2.4.1.

END OF SECTION

SECTION 18320

POWER SWITCH AND LOCK MOVEMENT

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for dual control switch and lock movement, including switch target, for each interlocked track switch at new switch locations as shown on the Drawings. In addition, relocate existing switch machines where indicated on the Contract Drawings

B. Refer to Division 20, Trackwork, for track construction requirements.

1.02 REFERENCE STANDARDS

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

1. Communications and Signals Manual of Recommended Practices (C&S Manual). When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

1.03 SUBMITTALS

A. Submit installation drawings showing the tie straps and the mounting details of the switch and lock movement, including the connections to the track switch points and target.

B. Submit Acceptance Test documentation on switch and lock movement prior to shipment of the movements.

C. Submit copies of all field test reports.

1.04 QUALITY ASSURANCE

A. Switch and lock movements shall meet the recommendations of AREMA C&S Manual Part 12.2.1 for dual control high voltage applications, where they do not conflict with any requirements specified herein.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect switch and lock movements and their component layout parts against damage during handling and shipment.

B. During storage, properly lubricate and maintain switch and lock movement layouts on a regular timed program.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Furnish complete dual control Electric Switch and Lock Movement Layouts, including switch targets.

B. Contractor-furnished Junction Box shall be RSE 6K1 Model N349656 manufactured by Ansaldo STS USA or Engineer approved equal.

C. Furnish Insulated Vertical No. 1 Rod with Basket.

D. Miscellaneous Fittings: Furnish all connectors such as threaded nipples, cable clamps, and electrical fittings as required for each switch and lock movement layout including 18-inch-long, 2-inch-diameter flexible conduit and connectors from movement to junction box.

2.02 SECURITY

A. Padlocks will be Owner-furnished.

2.03 SOURCE QUALITY CONTROL

A. Test each switch and lock movement before shipping it to the job site. Conduct this acceptance testing in accordance with the Contractor's Acceptance Test Procedure for switch and lock movements. Submit a copy of the Contractor's documentation of acceptance testing to the Engineer prior to shipping.

PART 3 - EXECUTION

3.01 GENERAL

A. Mount and adjust the complete switch and lock movement layout as specified herein and as indicated on the Contract Drawings.

B. Wire control and indication circuits for power-operated switches as shown on the Contract Drawings.

3.02 INSTALLATION

A. Prior to installation, coat all parts of the switch and lock movement that are not painted, or made of non-corroding material with an approved grease to prevent corrosion. Suitably plug or cap unused threaded outlets.

B. Where existing concrete ties are not used, install two 14 foot long timber ties for mounting the switch mechanisms where shown on the Contract Drawings. If a helper assembly is required, one of the switch mounting ties shall be 16 foot long.

C. Prior to mounting the switch mechanism on either concrete or timber ties, align the switch headblock ties at right angles to the straight stock rail, and space the ties in accordance with the switch shop drawings, and condition the switch points to move without binding.

D. Install the switch and lock movements at the locations shown on the Contract Drawings.

1. Secure switch and lock movement to the switch ties using eight 7/8-inch bolts.

E. Remove any ballast necessary for the installation of each switch and lock movement layout and replace and tamp ballast after the installation has been completed. Spread excess ballast evenly between ties in the vicinity of the switch and lock movement layout. Remove ballast from between ties to allow unrestricted movement of switch rods.

F. Make a preliminary adjustment of switch and lock layout at the time of installation and a final adjustment when placing it in service, which shall result in the adjusting nuts being centered on the threads plus or minus 30 percent of the thread length. Make final adjustment at the time of the functional test. Make final adjustments in conformance with the recommendations of AREMA C&S Manual Parts 12.2.1 and 2.4.1, and the PCJPB Test and Maintenance Manual Chapter 2.

G. Do not apply power to the motor until the switch machine has been fully lubricated, thrown, and adjusted in hand throw. There shall be no rubbing or binding of switch rods or points on gauge plates, rails or ties. Follow manufacturer's adjustment and installation procedure.

H. During storage and after installation, properly lubricate and maintain switch and lock movement layouts on a regular timed program until accepted by the Engineer.

I. Exercise care and ensure that the switches, including switch tie plates, are thoroughly lubricated at all lubricating points, that all machined surfaces susceptible to rusting, both external and internal, are thoroughly coated with grease, as acceptable to the Engineer, and that threaded portions of switch rods and nuts are similarly coated and protected.

J. Lubricate the switch tie plates with graphite lubricant, as acceptable to the Engineer. Thoroughly steam clean the plates to remove all oil or grease prior to application of the graphite. Periodically renew the protective coating until such time as the Owner assumes responsibility for maintenance of the equipment.

3.03 SECURITY

A. Install Contractor-furnished temporary switch padlocks on trainman's access side of electric locks, and power and hand-throw levers of switch and lock movements until final acceptance.

B. Upon final acceptance install Owner-furnished switch padlocks on trainman's access side of electric locks, and power and hand-throw levers of switch and lock movements.

3.04 TOUCH-UP

A. Touch-up the finish of equipment described in this Section in accordance with the AREMA C&S Manual, Part 1.5.10. Color shall match factory finish.

3.05 FIELD QUALITY CONTROL

A. Inspect each switch and lock movement after it has been installed and correct any deficiencies noted. Conduct this inspection in conformance with the requirements of the Contractor's Installation Inspection Procedure as accepted by the Engineer.

B. Conduct final operational tests of switch and lock movements as described in Section 18600, Signal Systems Testing.

END OF SECTION

SECTION 18330
SWITCH CIRCUIT CONTROLLER

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for switch circuit controllers.

1.02 GENERAL

A. Switch circuit controller layouts shall include the controller unit, junction box, point lug, detector rod, shims, all required bolts, nuts, washers, pins, grease fittings, cotter keys, plates, adjusting brackets, and all hardware to mechanically couple the switch circuit controller to the track switch points and mount it on the ties.

B. Refer to Division 20, Trackwork, for track construction requirements.

1.03 REFERENCE STANDARDS

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

1. Communications and Signals Manual of Recommended Practices (C&S Manual).

1.04 SUBMITTALS

A. Submit installation drawings showing the tie straps and the mounting details of the switch circuit controller, including the connections to the track switch points.

B. Submit Contractors Acceptance Test Documentation on switch circuit controllers prior to transport.

C. Submit copies of all field-test reports.

1.05 QUALITY ASSURANCE

A. Switch circuit controllers shall meet the recommendations of AREMA C&S Manual, Part 12.1.1, for a four front/back contact configuration where they do not conflict with any requirements specified herein. Mounting details shall conform to the Caltrain Design Standards.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect switch circuit controllers and their component layout parts against damage during handling and shipment.

B. During storage, properly lubricate and maintain switch circuit controller layouts on a regular timed program.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Furnish Electric Switch Circuit Controller Layout complete with rod, lug, and associated hardware.

B. Contractor furnished Switch Circuit Controllers and layouts, if required, shall be: Model 7J as manufactured by ASO, Model U-5 as manufactured by Hitachi Rail STS, or Engineer approved equal, complete with rod, lug and associated hardware.

C. Contractor furnished Junction Box shall be Model 091 428-ABX manufactured by Siemens or Engineer approved equal.

D. Furnish Insulated Vertical No. 1 Rod with Basket.

E. Miscellaneous Fittings: Furnish all connectors such as threaded nipples, cable clamps, and electrical fittings as required for each switch and lock movement layout including 18-inch-long, two-inch-diameter flexible conduit and connectors from movement to junction box.

2.02 GENERAL

A. Stranded wire: Furnish insulated No. 10 AWG stranded wire between the pedestal-mounted junction box and the switch circuit controller. Insulated wire shall be in accordance with Section 18370, Signal Wire and Cable.

B. Miscellaneous Fittings: Furnish all connectors such as threaded nipples, cable clamps, and electrical fittings as required for each switch circuit controller layout.

2.03 SECURITY

A. Padlocks will be Owner-furnished.

2.04 SOURCE QUALITY CONTROL

A. Test each switch circuit controller before transporting it to the job site. Conduct this acceptance testing in accordance with the Contractor's Acceptance Test Procedure for switch circuit controllers.

PART 3 - EXECUTION

3.01 GENERAL

A. Mount and adjust the complete switch circuit controller layout as specified herein and as indicated on the Contract Drawings.

B. Circuits for switch circuit controllers shall be as shown on the Contract Drawings.

3.02 INSTALLATION

A. Prior to installation, coat all parts of the switch circuit controller that are not painted or made of non-corroding material with an approved grease to prevent corrosion. Suitably plug or cap unused threaded outlets.

B. Install one 10-foot long timber tie or concrete tie for mounting the controllers as shown on the Contract Drawings

C. Mount controllers on new and existing timber or concrete ties in conformance to Caltrain Design Standards.

D. Dap and drill timber ties to meet the requirements of these Specifications. Limit of cutting or dapping shall not exceed 2 inches.

E. Secure the switch circuit controller to the switch ties, by 3/4 inch by 10 1/2 inch bolts.

F. Remove any ballast necessary for the installation of each hand throw switch layout and replace and tamp the ballast after the installation has been completed. Spread excess ballast evenly between ties in the vicinity of the switch and lock movement layout.

G. Make a preliminary adjustment of the controller layout at the time of installation and a final adjustment when placing it in service, which shall result in the adjusting nuts being centered on the threads plus or minus 30 percent of the thread length. Make final adjustment at the time of the functional test. Make final adjustments in conformance with the requirements of AREMA C&S Manual, Parts 12.1.1 and 2.4.1.

H. Underground cable terminating in the controller junction box shall be dressed and potheaded as specified in Section 18370, Signal Wire and Cable. Fan the individual conductors in a neat workmanlike manner, properly tagged and terminated. Wiring between switch junction box and switch circuit controller shall be No. 10 AWG insulated stranded flex wire. These wires shall also be tagged and terminated. Install the wires between the controller junction box and the controller mechanism in an approved flexible conduit with a minimum length of 10 inches and a maximum length of 21 inches. Fasten this flexible conduit to the switch junction box and switch mechanism with appropriate connectors.

I. After installation, properly lubricate and maintain switch circuit controller layouts on a regular timed program until accepted by the Engineer.

J. Exercise care and ensure that the controllers, including switch tie plates, are thoroughly lubricated at all lubricating points, that all machined surfaces susceptible to rusting, both external and internal, are thoroughly coated with grease, as acceptable to the Engineer, and that threaded portions of switch rods and nuts are similarly coated and protected.

K. Lubricate the switch tie plates with graphite lubricant, as acceptable to the Engineer. Thoroughly steam cleaned the plates to remove all oil or grease prior to application of the graphite. Periodically renew the protective coating until such time as the Owner assumes responsibility for maintenance of the equipment.

L. Connect switch circuit controller rods to the normally closed switch point.

3.03 SECURITY

A. Install Contractor-furnished temporary switch padlocks on trainman's access side of electric locks, and power and hand-throw levers of switch and lock movements until final acceptance

B. Upon final acceptance install Owner-furnished switch padlocks on trainman's access side of electric locks, and power and hand-throw levers of switch and lock movements.

3.04 TOUCH-UP

A. Touch-up the finish of all equipment described in this Section in accordance with the AREMA C&S Manual, Part 1.5.10. Touch-up shall match factory finish.

3.05 FIELD QUALITY CONTROL

A. Inspect each switch circuit controller after it has been installed and correct any deficiencies noted. Conduct this inspection in conformance with the requirements of the Contractor's Installation Inspection Procedure as accepted by the Engineer.

B. Conduct final operational tests of switch circuit controllers as described in Section 18600, Signal Systems Testing.

C. Test all functions of each switch and lock movement layout in accordance with Section 18600, Signal Systems Testing.

END OF SECTION

SECTION 18340
ELECTRIC SWITCH LOCK LAYOUTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for Electric Switch Lock layouts.

1.02 GENERAL

A. Refer to Division 20, Trackwork, for track construction requirements.

1.03 REFERENCE STANDARDS

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

1. Communications and Signals Manual of Recommended Practices (C&S Manual).

1.04 SUBMITTALS

A. Submit installation drawings showing the tie straps and the mounting details of the switch circuit controller, including the connections to the track switch points.

B. Submit copies of all field-test reports.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prior to installation, coat all parts of the Electric Switch Lock layout that are not painted or made of non-corroding material with an approved grease to prevent corrosion. Suitably plug or cap unused threaded outlets.

B. During storage, lubricate and maintain Electric Switch Lock and switch circuit controller layouts on a regular time program until installation. The Engineer shall have the right to monitor the Contractor's compliance with this maintenance required from time to time.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Furnish new Low Style Electric Lock Operating Mechanisms and layouts, such as G & B Specialties Model 854 or ASO Model 10A.

B. Furnish new High Style Electric Lock Operating Mechanisms and layouts, such as ASO Model 9B or Hitachi Rail STS Model SL6A.

C. Rods and Hardware. Each Low Style Electric Switch Lock shall securely lock the switch hand throw lever in the normal position only. Provide a single color LED with the assembly to indicate switch lock release. Each High Style Electric Lock shall have a separate lock rod attached to the vertical front rod.

D. Junction Boxes. Each Electric Switch Lock layout shall be installed with an individual pedestal mounted junction box. These junction boxes shall be as specified in Section 18360, Signal Systems Miscellaneous Products.

E. Electrical Fittings. All conduit, connectors, and electrical fittings, as required, for each electrical lock layout.

F. Switch Circuit Controller and Rod. Switch circuit controller layouts shall be installed as specified in Section 18330, Switch Circuit Controller.

G. Stranded wire: Furnish insulated No. 10 AWG stranded wire between the pedestal-mounted junction box and the switch circuit controller. Insulated wire shall be in accordance with Section 18370, Signal Wire and Cable.

2.02 SECURITY

A. Provisions shall be made for the use of standard padlocks:

1. A switch padlock to restrict entry into the operating handle location of the Electric Switch Lock.

2. Signal padlocks to restrict entry into the Electric Switch Lock operating mechanism, the circuit controller, and the junction box.

B. Install Contractor-furnished temporary padlocks switch padlocks on trainman's access side of electric locks, and power and hand-throw levers of switch and lock movements until final acceptance.

C. Upon final acceptance install Owner-furnished switch padlocks on trainman's access side of electric locks, and power and hand-throw levers of switch and lock movements.

2.03 SOURCE QUALITY CONTROL

A. Perform Contractor’s acceptance test of each Electric Switch Lock layout prior to transporting the Electric Switch Lock layout.

PART 3 - EXECUTION

3.01 GENERAL

A. The circuits for Electric Switch Lock layouts shall be as shown on the Contract Drawings.

B. Mount and adjust the complete switch circuit controller layout as specified herein and as indicated on the Contract Drawings.

3.02 INSTALLATION

A. Install two 16-foot long timber ties or concrete ties for mounting the Electric Switch Lock where ASO Model 9B or Hitachi Rail STS Style SL-6A Electric Locks are used and controller by the Contractor, as shown on the Contract Drawings.

B. Mount Electric Switch Lock and controller on new and existing timber or concrete ties in conformance to Caltrain Design Standards.

C. Dap and drill timber ties to meet the requirements of these Specifications. Limit of cutting or dapping shall not exceed 2 inches.

D. Secure the Electric Switch Lock and switch circuit controller to the switch ties, by 3/4 inch by 10 1/2 inch bolts.

E. Remove any ballast necessary for the installation of each Electric Switch Lock layout and replace and tamp the ballast after the installation has been completed. Spread excess ballast evenly between ties in the vicinity of the switch and lock movement layout.

F. Make a preliminary adjustment of the Electric Switch Lock and switch circuit controller layout at the time of installation and a final adjustment when placing it in service, which shall result in the adjusting nuts being centered on the threads plus or minus 30 percent of the thread length. Make final adjustment at the time of the functional test. Make final adjustments in conformance with the requirements of AREMA C&S Manual, Parts 12.5.5 and 2.4.1.

G. Underground cable terminating in the Electric Switch Lock and switch circuit controller junction boxes shall be dressed and potheaded as specified in Section 18370, Signal Wire and Cable. Fan the individual conductors in a neat manner, properly tagged and terminated. Wiring between switch junction box and Electric Switch Lock and switch circuit controller shall be No. 10 AWG insulated stranded flex wire. These wires shall also be tagged and terminated. Install the wires between the Electric Switch Lock and switch circuit controller junction box and the Electric Switch Lock and switch circuit controller mechanisms in an approved flexible conduit with a minimum length of 10 inches and a maximum length of 21 inches. Fasten this flexible conduit to the switch junction box and switch mechanism with appropriate connectors.

H. After installation, properly lubricate and maintain Electric Switch Lock and switch circuit controller layouts on a regular timed program until accepted by the Engineer.

I. Exercise care and ensure that the Electric Switch Lock and switch circuit controllers, including switch tie plates, are thoroughly lubricated at all lubricating points, that all machined surfaces susceptible to rusting, both external and internal, are thoroughly coated with grease, as acceptable to the Engineer, and that threaded portions of switch rods and nuts are similarly coated and protected.

J. Lubricate the switch tie plates with graphite lubricant, as acceptable to the Engineer. Thoroughly steam clean the plates to remove all oil or grease prior to application of the graphite. Periodically renew the protective coating until such time as the Owner assumes responsibility for maintenance of the equipment.

K. Connect electric switch lock rod and switch circuit controller rods to the normally closed switch point.

3.03 SECURITY

A. Install Contractor-furnished temporary padlocks switch padlocks on trainman's access side of electric locks, and power and hand-throw levers of switch and lock movements until final acceptance.

B. Upon final acceptance install Owner-furnished switch padlocks on trainman's access side of electric locks, and power and hand-throw levers of switch and lock movements.

3.04 TOUCH-UP

A. Touch-up finish of all equipment described in this Section in accordance with the AREMA C&S Manual, Part 1.5.10. Touch-up shall match factory finish.

3.05 FIELD QUALITY CONTROL

A. Inspect each Electric Switch Lock after it has been installed and correct any deficiencies noted. Conduct this inspection in conformance with the requirements of the Contractor's Installation Inspection Procedure as accepted by the Engineer.

B. Conduct the final operational tests of switch circuit controllers as described in 18600, Signal System Testing.

END OF SECTION

SECTION 18350

RECTIFIERS, BATTERIES AND BATTERY CHARGING EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for rectifiers, batteries, and battery charging equipment.

1.02 REFERENCE STANDARDS

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

1. Communications and Signals Manual (C&S Manual). When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

1.03 DESIGN REQUIREMENTS

A. Calculate the loads based upon the equipment proposed. Size all batteries to provide a minimum 48 hours standby capacity for all systems based on normal operating conditions. Verify the ampere-hour capacity shown on the Contract Drawings is adequate to provide a minimum of 48 hours standby capacity.

1. Size battery to provide a minimum of 48 hours of uninterrupted power to the signal systems at the normal operating load.

B. Highway Grade Crossings will include separate back-up batteries for equipment and warning devices.

1. Equipment Battery to be sized to provide a minimum of 48 hours of uninterrupted power to the highway grade crossing warning system at normal load. (Equipment utilized in highway grade crossings includes devices utilized for detection, event recording and control such as the XP-4, HXP3, GCP3000, SEAR, AFTAC and PSO4000.)

2. Warning Device Battery to be sized to provide a minimum of 12 hours of continuous operation with the gate arms in the horizontal position, with all lights and bells activated. A 7th cell of battery shall be installed for this battery bank. (Warning Devices utilized in highway grade crossing systems include all gates, flashers, bells, and other warning device equipment such as blankout signs.)

1.04 SUBMITTALS

A. Load calculations of each dc and ac load. Submit calculations identifying normal and worst-case conditions for each load.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MATERIALS

A. DDR Batteries: Batteries conforming to the requirements specified herein as manufactured by Enersys or Engineer approved equal.

1. Model (DDr 50-17, 400AH)

B. National Railway Supply HF-MAX Battery Charger: Charger conforming to the requirements specified herein or Engineer approved equal:

1. Model HF-MAX (12/40 with temperature and voltage cables)

2.02 EQUIPMENT DETAILS

A. Battery charging equipment shall be designed for continuous operation.

B. Battery charging equipment shall be designed to deliver rated outputs with input voltage of 100 V to 130 V at 60 Hz, single phase, two wire input.

C. Battery charging equipment shall have a reserve capacity of at least 25 percent above the calculated high load requirements.

D. Each charger shall be provided with programmable output voltage adjustment.

E. Terminal markings for ac and dc terminals shall be permanent.

F. The charger shall provide a stabilized output voltage, temperature compensated with output current limiting. The capacity of the battery charger shall be determined by the Contractor and approved by the Engineer. The charger shall adjust its output current automatically, according to the load and to the demand on the battery.

G. Battery charger shall conform to requirements in AREMA C&S Manual Part 9.2.1. The output of the charger shall be sufficiently filtered to be compatible with the input voltage requirements of the solid-state interlocking units, and all other electronic equipment for the signaling system.

H. Batteries shall be valve regulated lead acid recombinant technology.

I. Batteries shall be capable of a minimum of 1,500 charge-discharge cycles to 80 percent discharge without loss of capacity. Totally discharged batteries, even if polarity has reversed, shall be capable of being recharged to rated capacity with charging voltage of no more than 2.27 volts per cell.

J. Batteries shall be installed in trays and have straps installed.

2.03 MISCELLANEOUS MATERIALS

A. Furnish all mounting hardware, terminals, and terminators, and similar items for mounting chargers and batteries in wayside cases and signal instrument shelters.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install batteries and battery charging systems as shown on the Contract Drawings.

3.02 TESTS

A. Perform tests specified in Section 18600, Signal Systems Testing, ensuring system operation.

B. Test batteries and battery chargers in accordance with the manufacturer's standard when installed.

END OF SECTION

SECTION 18360

SIGNAL SYSTEMS MISCELLANEOUS PRODUCTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for miscellaneous components and products for signal systems.

1.02 REFERENCE STANDARDS

A. American National Standards Institute (ANSI)

1. C80.1 Electrical Rigid Steel Conduit

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

1. Communications and Signals Manual of Recommended Practices (C&S Manual). When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's catalog cuts, material descriptions, specifications, and other data pertinent to the miscellaneous products required.

B. Submit samples of solderless crimp-on type terminals.

1.04 EXTRA MATERIALS

A. Furnish two gallons or equivalent volume of corrosion preventive compound. Compound shall be the same product as approved for use in the Work.

PART 2 - PRODUCTS

2.01 GENERAL

A. All electrical components shall be rated to operate at power, voltage, current, and temperature levels exceeding by 20 percent those which the components will be subject to in service, unless otherwise specified herein.

B. Miscellaneous components and products shall be clearly and permanently labeled with value or type identification.

2.02 CIRCUIT BREAKERS AND FUSES

A. Circuit breakers and fuses shall be of suitable capacity to protect the various pieces of signal apparatus from the effects of short circuits or overloads. All circuit

breakers and fuses required for the equipment and systems shall be in accordance with these Specifications.

B. Circuit fuses shall be non-renewable, and shall be of the fiber-case, time lag, fusion type.

C. The circuit breakers and fuses shall be the correct size and rating for circuit current interruption and shall protect the electrical equipment and circuits from short-term and long-term overloads.

D. All circuit breakers and fuses shall be centrally located on the power distribution panel and power racks.

E. Fuse clips shall be constructed so that they shall retain their resilience under all installation and service conditions, to ensure a positive contact between the clips and the fuse.

2.03 DIODES

A. Diodes to be furnished under this Contract shall carry a JEDEC number or shall be available from more than one manufacturer, and shall be used within the published specifications for such number. All diodes shall be silicon type, unless otherwise accepted by the Engineer.

2.04 RESISTORS

A. Resistors, other than those required for electronic circuits, shall be in accordance with AREMA C&S Manual Part 14.2.15.

2.05 REACTORS

A. Reactors, other than those required for electronic circuits, shall be in accordance with AREMA C&S Manual Part 14.2.20.

2.06 SIGNAL TERMINAL BLOCKS

A. Signal system terminal blocks shall be in accordance with the applicable recommendations of AREMA C&S Manual Part 14.1.5.

2.07 TERMINAL BINDING POSTS

A. Signal system terminal binding posts shall be in accordance with the applicable recommendations of AREMA C&S Manual Part 14.1.10.

B. Terminal binding posts for interface with plug-coupled wires to rack mounted electronic equipment shall be in accordance with the recommendations of AREMA C&S Manual, Part 14.1.2.

2.08 TERMINAL POST INSULATORS

A. All terminal posts, located on terminal boards in the wayside cases, signal instrument shelters used to terminate 50V, or greater, ac or dc circuits shall be provided with a protective insulator.

B. The type of insulator shall be individual for each terminal post and shall be fire-resistant.

2.09 INSULATED TEST LINK

A. Type NYK: 024620-1X as manufactured by Siemens, or Engineer approved equal.

2.10 LIGHTNING ARRESTERS AND EQUALIZERS

A. Siemens Clearview (Standard Duty) NYK:40004448528X1, Siemens Rail Clearview (Heavy Duty) no. NYK:400044585001X, and Clearview Equalizer NYK:40004470001X1, or engineer approved equal. Lightning arresters and equalizers shall be mounted on accepted type base and shall be in accordance with the recommendations of AREMA C&S Manual Part 11.3.1.

2.11 SURGE PROTECTORS

A. Siemens SP-17, SP-18, SP-19, SP-20, or equal. Surge Protectors shall be in accordance with the recommendations of AREMA C&S Manual Part 11.3.3.

2.12 TERMINALS FOR WIRES AND CABLES

A. Solderless terminals shall be in accordance with the recommendations of AREMA C&S Manual, Part 14.1.1, unless otherwise specified herein.

B. Terminals shall be of the solderless crimp-on type. Samples of all solderless terminals shall be submitted for approval.

C. Stranded copper wire shall be fitted with an approved type of terminal at all points where the wires are to be terminated on terminal binding posts.

D. The terminating means shall be of four types:

1. A lug for terminating heavy wires or signal power wires.

2. A solderless type of terminal as manufactured by TE Connectivity, Inc., under the trade name of "Pre-Insulated Flags" with translucent insulation similar to Catalog No. 322313, or equal, for terminating No. 16 and No. 14, American Wire Gauge (AWG) stranded wires.

3. An AMP Solistrand "Ring Tongue-Flat" terminal, similar to that shown on the AMP Drawing P64044, together with slip-on nylon post insulator, similar to that shown on AMP Drawing P64-0264, or equal, for terminating wires larger than No. 14 AWG to a maximum diameter over the insulation of 0.40 inch.

4. An AMP preinsulated; diamond grip ring nylon insulated wire terminal shall be used for terminating other stranded wires, No. 20 and No. 18 AWG, having maximum diameter of 0.125 inch. AMP Catalog No. 320554, or equal, shall be furnished for No. 8 studs and AMP Catalog No. 320571, or equal, shall be furnished for 1/4-inch studs.

E. Terminals shall be for attaching to the ends of the conductor in such a manner that the flexibility of the conductor will not be destroyed and the possibility of breakage at the terminal will be reduced to a minimum.

F. Terminals shall be for attaching to the wire with a tool made by the manufacturer of the terminal and recommended by the manufacturer for the terminals being furnished.

G. The tool shall be equipped with a ratchet device to ensure proper indentation of the terminal, which will not release until proper indentation is complete.

2.13 TAGGING FOR CABLES, WIRES AND EQUIPMENT

A. Except as otherwise specified in this Section, permanently identify with a tag both ends of each cable, each cable wire, and all single wires that terminate in the junction boxes, switch mechanisms, signal instrument shelters, on equipment racks, relay bases, shelter and any equipment of the signal system outside of such locations. Install tags so that they may be read with a minimum of disturbance of the tags. Each conductor of the cable shall be rung out and identified before applying the tag. Tagging shall follow the three-line convention with the termination in the first line, nomenclature in the second line, and termination of the other end of the wire in the third line. (From - To)

B. Tags for wire and cable identification and for identification of transformers, resistors, reactors and other components shall meet the following requirements and shall be subject to Engineer's acceptance:

1. Sleeve Type Tags:

a. Tags for identifying individual cable conductors and field-installed wires within the signal instrument shelters, wayside cases, switch mechanisms, switch layout junction boxes, base of signal junction boxes, and similar applications, shall be the sleeve type as manufactured by Raychem Corporation, Thermofit Marker System (TMS), or equal. The application of the conductor nomenclature shall be in accordance with the manufacturer's instructions and shall result in a permanently bonded and legible identification.

2. Flat Plastic Tags:

a. Tags for identification of vital relay plug boards, individual transformers, resistors, reactors, terminals, and other miscellaneous components within the signal instrument shelters, wayside cases, and outside terminal cases, shall be the flat plastic laminated type.

b. These tags shall be 1-1/2 inches long by 1/2-inch-wide. The untreated tag shall be milk white "vinylite", or Engineer approved equal.

c. The identifying nomenclature space shall allow for two 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 1/8 inch.

d. After lettering, both the face and backside of the tag shall be covered with a clear plastic coating, "vinylite", or Engineer approved equal.

2.14 HARDWARE

A. Mounting hardware exposed to the elements and used for signal equipment, cases, conduit, hangers, brackets, clamps, and the like, shall be hot-dip galvanized in accordance with AREMA C&S Manual Part 15.3.1, except as otherwise accepted by the Engineer.

B. Galvanizing:

1. The hot-dip process of galvanizing shall be used. All parts shall be picked so that all scale and adhering impurities are removed. The zinc coating shall be of commercially pure zinc, and shall be continuous and thorough. It shall not scale, blister, or be removable by any of the processes of handling or installation. The finished surface shall be free from fine line cracks, holes, or other indications of faulty galvanizing. It shall be smooth and free from adhering flux and other impurities. The edges and ends of parts shall be free from lumps and globules. Parts shall be coated with at least two ounces of zinc per square foot of galvanized surface, after all bending, cutting, drilling, and final fabrication.

C. Cadmium Plating:

1. Nuts, bolts, and washers shall be cadmium plated or stainless.

2. Cadmium plating shall be an impervious, dense, hard, fine grained, continuous, closely adhering coating of commercially pure cadmium, free from capillaries and shall completely cover the surface of the part in a smooth, bright layer. Plating on raised or prominent portions shall show no evidence of blackness or loose crystalline structure. It shall have a minimum thickness of six ten thousandths of an inch and shall withstand the salt spray test for at least 1,000 hours or an equivalent test accepted by the Engineer.

2.15 CONDUIT

A. Rigid conduit:

1. Steel Conduit: Steel conduit shall conform to ANSI C80.1 and shall be installed as shown on the Contract Drawings. Where elbows are used, they shall be long radius type. Steel conduits shall be protected in shipping and handling by approved thread protectors.

2. Polyvinyl Chloride (PVC) Conduit: Thick wall polyvinyl chloride conduit, high impact schedule 80, herein referred to as PVC conduit, shall be installed as shown in the Contract Drawings. Where elbows are used, they shall be the long radius type.

B. Flexible Conduit

1. Conduit for track circuit leads, switch-and-lock movements, and electric lock layouts shall be Liquid-Tite flexible conduit or equal. The conduit shall be clamped at both ends with stainless steel clamps. Clamps are not required for track wire risers.

2. Metallic Flexible Conduit: Where acceptable to the Engineer, metallic flexible conduit, Type UA, or engineer approved equal may be used.

C. Fittings

1. Approved fittings for flexible conduit shall be used.

2. Approved fittings for PVC conduit shall be used.

3. Fittings for rigid steel conduit shall be of cast malleable iron and shall be protected by hot-dip galvanizing.

2.16 PADLOCKS

A. Install Contractor-furnished temporary switch padlocks on trainman's access side of electric locks, and power and hand-throw levers of switch and lock movements until final acceptance

B. Upon final acceptance install Owner-furnished switch padlocks on trainman's access side of electric locks, and power and hand-throw levers of switch and lock movements.

2.17 SEALING COMPOUND

A. Sealing compound for use in sealing cable entrances shall be in accordance with AREMA C&S Manual Part 15.2.15.

2.18 CABLE ENTRANCE PIPES

A. Cable entrance pipes for wayside signal shelters shall be 4-inch PVC, Schedule 80, and 3 feet 6 inches long and extend 18 inches below the final grade.

B. Cable entrance for wayside signals shall be 4 inch Liquid-Tite flexible conduit or equal. Entrance pipe shall extend 18 inches below finished grade around signal.

C. Cable entrance pipes are not required where a cable chute directly enters a pullbox.

2.19 JUNCTION BOXES

A. All junction boxes shall be provided with gaskets to prevent the entrance of moisture and dust, in accordance with AREMA C&S Manual Part 15.2.10.

B. Junction boxes shall be provided to terminate underground cables at all switch and lock movements and all switch circuit controllers.

C. Junction boxes shall be provided with means for applying padlock.

2.20 LUBRICATION

A. Lubrication for switch tie plates for all switch and lock movement layouts installed by the Contractor shall be an accepted graphite lubricant, similar to Dixon's Graphite "Railroad 60".

2.21 ENVIRONMENTAL PROTECTION (CORROSION PREVENTIVE COMPOUND)

A. Protection, as hereinafter specified for machine-finished surfaces, threaded rods, nuts, and other parts that are susceptible to rusting or corroding, shall be a corroding preventive compound, NO-OX-IDE No. 90918, or equal. The product shall have sufficient body to resist weather and rusting for at least 6 months.

2.22 DC TRACK CIRCUITS

A. Transmitters shall be a 1TC, 2TC, or 3TC manufactured by ASO or Engineer approved equal.

2.23 STYLE C TRACK CIRCUITS

A. Transmitter shall be a TD-1A driven by an ACG-2T or TD-4 manufactured by GETS Global Signaling or Engineer approved equal.

2.24 AUDIO FREQUENCY ISLAND TRACK CIRCUITS

A. Audio frequency island track circuits shall be AFTAC-II manufactured by ASO, PSO4000 manufactured by Siemens, or Engineer approved equal.

2.25 AC TRACK CIRCUITS

A. AC Track Circuits shall be steady energy such as the SE-3 manufactured by Siemens or Engineer approved equal. Vane Relays shall not be used.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Material and apparatus specified herein shall be installed in accordance with the details of respective Sections of these Specifications, manufacturer's recommendations, and in accordance with the Contractor's accepted installation drawings approved by the engineer.

END OF SECTION

SECTION 18370
SIGNAL WIRE AND CABLE

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for all cable and wire required for signal and signal power system wiring to wayside shelters, junction boxes, and factory wired mechanisms.

1.02 REFERENCE STANDARDS

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

1. Communications and Signals Manual (C&S Manual). When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

B. International Organization of Standardization (ISO):

1. 9001 Quality Management Systems

1.03 SYSTEM DESCRIPTION

A. Material and workmanship shall be of the highest quality, assuring durability for minimum life expectancy of 40 years. Cables shall be suitable for use in the environment to be encountered on a railroad signal system, and shall be certified for continuous operation, in wet or dry locations, with no conductor failing in continuity or with loss of insulation to cross or ground less than one megohm.

1.04 SUBMITTALS

A. Product Data: Manufacturer's catalog cuts, material descriptions, and specifications for each type of wire and cable the Contractor proposes to provide.

B. Quality Assurance: Submit a list of cable manufacturer's installations complying with the past performance and experience requirements specified herein.

1.05 QUALITY ASSURANCE

A. Cable manufacturer's qualifications shall be as follows:

1. Past Performance and Experience: Demonstrated previous successful experience in supplying cable to the railway or transit industry for use as vital signal control cables. A list of such installations shall be provided for each cable manufacturer to be considered.

2. Quality Assurance Program: The manufacture of cables in accordance with the requirements of these specifications shall be accomplished in compliance with a Quality Assurance Program that meets the intent of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Shipping, storage, and handling shall be in accordance with the recommendations of AREMA Signal Manual, Part 10.4.1.

B. During storage and handling, prior to final conductor termination, cable ends shall be sealed to prevent the entrance of moisture.

PART 2 – PRODUCTS

2.01 INTERNAL WIRE AND CABLE

A. Individual cable make-up and conductor sizes shall be as shown on the Contract Drawings.

B. Internal wire and cable shall conform to the recommendations of AREMA C&S Manual, Part 10.3.14, and the following requirements:

1. Solid conductors shall be Type I in accordance with AREMA C&S Manual Part 10.3.14.

2. Stranded conductors shall be Type II in accordance with AREMA C&S Manual Part 10.3.14.

C. Internal wire and cable insulation shall conform to the recommendations AREMA C&S Manual Part 10.3.24 and the following requirements:

1. The minimum insulation rating shall be 600 volts.

2.02 EXTERNAL WIRE AND CABLE

A. General

1. Individual cable make-up and conductor sizes shall be as shown on the Contract Drawings.

2. Conductors shall be soft or annealed copper, coated with tin in accordance with Type I wire as shown in the applicable AREMA C&S Manual Part.

3. Stranded conductors shall be soft or annealed copper, coated with tin in accordance with Type II wire as shown in the applicable AREMA C&S Manual Part.

4. All signal and communications cable shall enter shelter through the floor of the shelter.

B. Track Wire

1. Track wire shall be Okonite-Okolene(EP-PE) manufactured by Okonite Co., or Engineer approved equal.

2. Track wire shall meet the recommendations of AREMA C&S Manual, Part 10.3.15.

C. Signal, Switch, and Express Cable

1. Wire and cable used for direct burial to signals, to switches and express cable shall be Okonite (EP) Armored Underground Signal Cable manufactured by Okonite Co., or Engineer approved equal.

2. Conductors number six (#6AWG) and smaller shall be solid. Conductors number 4 (#4AWG) and larger shall be stranded.

3. Armored cable used for direct burial shall be furnished with a 10-mil flat bronze tape between the conductors and the outer jacket, helically applied, and adequately cushioned from the conductors.

4. Armored cable shall meet the recommendations of AREMA C&S Manual, Part 10.3.17.

5. Any cable installed in conduit or trough for its entire run need not be armored, but shall meet the recommendations of AREMA C&S Manual Part 10.3.16.

D. AC Power Cable

1. AC power shall be Okonite-FMR (EP) Okolon (CSPE) Type TC Cable manufactured by Okonite Co., or Engineer approved equal.

2. Cable shall meet the recommendations of AREMA Signal Manual, Part 10.3.16.

E. Modem Cable

1. Modem cables shall be C-L-X Type SP-OS manufactured by Okonite Co., or Engineer approved equal.

2. Modem cable shall be protected by a moisture impervious, continuously welded, corrugated, aluminum sheath with an overall EFTE fluoropolymer jacket.

3. Individual twisted pairs shall be separately shielded with an aluminum polyester tape to provide shield isolation between pairs of 100 megohms per 1000 ft. minimum.

4. Modem cable shall meet the requirements of AREMA Signal Manual, Part 10.3.17 except as specified herein.

2.03 SOURCE QUALITY CONTROL

A. Coordinate with the Engineer for Engineer's inspections and tests at point of product.

B. Provide, at the point of production, apparatus and labor for the following tests:

1. Conductor size and physical characteristics

2. Insulation HV and IR tests

3. Physical dimension tests

4. Special tests on materials in coverings

5. Final HV, IR, and conductor resistance tests on shipping reels

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. The installation of wire and cable shall conform to AREMA C&S Manual Parts 10.4.1, 10.4.30, except as specified herein.

2. All external cable runs shall be direct burial or in conduit in accordance with the PCJPB Communication & Signaling Standard Drawings, and as called for in the Contract Drawings.

3. The Contractor shall separate signaling cables from parallel run of ac feeder cables, where adjacent locations are fed from one ac service location.

4. Give the Engineer 24 hours notice prior to installing cables.

5. Provide sufficient slack in cable conductors at all terminating posts to enable three terminations of the conductor, due to broken eyelets without re-servicing or repotheading the cable.

6. In certain types of installation, the cable cannot be constrained; therefore, ample cable slack shall be provided for additional flexibility due to vibration of such equipment.

7. Do not bend cables to a radius less than manufacturer's recommendation.

8. Distribution cable runs shall be continuous without splices between cable terminating locations. Express cable runs longer than cable lengths shall be spliced together in junction box, instrument case, or other acceptable shelter. Prior to any cable or wire splicing, obtain the Engineer’s approval. Approval will not be granted for cables damaged by the Contractor or vandalized by others. It is the responsibility of the Contractor to protect all cables until final installation.

9. Identify individual cable conductors at each cable termination with plastic tags, as specified in Section 18360, Signal Systems Miscellaneous Products. Identify and terminate all spare conductors in each cable.

10. Seal cable entrance openings in equipment enclosures and junction boxes with either compression type fitting or pliable sealing compound after the cable is in place. Use sealing compound to seal the area around cable where the cable emerges from the end of a conduit or pipe. Seal and plug all spare conduits.

11. Wherever multiple conductor cables are terminated, carefully remove the outer sheath of the cable to a minimum point of 3 inches from the cable entrance. At the end of the cable sheath or covering, apply two layers of plastic electrical tape.

12. Terminate all cable conductors in conductor sequence from top to bottom.

13. Cable shields or sheaths shall be grounded at the entrance to signal shelters and shall float when terminated in field apparatus.

14. All signal and communications shall enter the shelter through the floor of the shelter.

B. Underground Buried Installation

1. Bury cable to a uniform minimum depth of 36 inches as measured from bottom of tie to top of cable, unless installed in a cable trough. When paralleling the tracks, bury cable a minimum depth of 36 inches as measured from the finished grade to top of cable. Lay cable loosely in trench with a sand bed and backfill as specified in these Specifications. Install cable within four-inch PVC schedule 80 conduit at a uniform minimum cover depth of 36 inches below grade when passing under tracks.

2. Upon request and only under extreme circumstances because of installation hardship will installation of a cable be allowed to a depth of less than 36 inches, subject to the Engineer's acceptance. Protect the cable in a manner acceptable to the Engineer.

3. Whenever any signal cable is to pass under pavement or roadway, if existing conduit is not provided, install cable in a 4-inch PVC Schedule 80 conduit and extend conduit 2 feet beyond the edges of the pavement. Installation of conduits and pull boxes shall be in accordance with Caltrain Standard Drawings (SD-5000 series), for typical installations. Restore pavement or roadway to its original condition, subject to the Engineer's acceptance.

4. Whenever any signal cable is to pass under the hot-mix asphalt concrete (HMAC) underlay installed at interlockings, install cable in conduit with pull boxes in accordance with Caltrain Standard Drawings (SD-5000 series).

5. Where cable leaves the ground at other than buildings or in foundations, protect cable by a bootleg or other covering extending above the ground line. Fill top of such protective coverings with a sealing compound.

6. Where buried cables enter a concrete foundation, junction box, shelter or case, leave sufficient slack in each cable in the nearest pullbox to allow an additional one foot of cable to be pulled into the shelter or junction box.

7. The potheading of buried cables shall be applied whenever cable is terminated in signal equipment, and such termination is within two feet of the grade level. This neoprene and seal pothead shall be installed in accordance with the manufacturer's instructions.

8. Cables shall not cross one another when they are pulled into a conduit or pipe; the conductors shall not be pulled tight or kinked in conduit fittings or boxes. All cables to be installed in a conduit or pipe shall be pulled and installed simultaneously.

9. Cables, track wire, and conduits shall be installed per Contract Drawings and Sections 02300 Earthwork.

10. All cables except final connection of flex wires to rail shall be installed in a conduit system as shown on the Contract Drawings.

C. Special Protection: Provide appropriate special protection for cables in areas where the cables are unavoidably exposed to hazardous conditions, such as vibration or sharp corners on equipment. Replace any cable that is installed but subsequently damaged prior to acceptance as a result of the Contractor's failure to provide such special protection.

D. AC Power Cable

1. AC power cable shall be installed in dedicated conduit from the service meters to the signal shelters and between signal shelters.

3.02 REPAIR

A. Immediately call to the Engineer's attention any instance of damaged cable observed at any time, whether prior to installation, occurring during construction, or discovered by test observation after installation. The method of correction shall be in accordance with the Engineer's written instruction. Promptly repair such damage.

3.03 FIELD QUALITY CONTROL

A. Test all installed external cable in accordance with the requirements of Section 18600, Signal Systems Testing, and AREMA C&S Manual, Part 10.4.30.

END OF SECTION

SECTION 18400
RAIL BONDING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for rail bonds, fouling bonds, frog bonds, track circuit connections, and all other material required for bonding of track circuit joints, track frog and switch bonding, and track circuit connections.

1.02 SYSTEM DESCRIPTION

A. Welded Bonds and track connections shall be in accordance with the requirements of PCJPB Standards.

B. Rail track joints shall be bonded with welded railhead bonds per PCJPB standards.

C. Track switch, frog fouling bonds, and track connections shall be stranded bonds.

D. Crimped sleeves shall not be used for any fouling or frog bonding unless allowed by PCJPB Manager of Signals and Communications through the Engineer.

1.03 QUALITY ASSURANCE

A. Install and test the track bonds in accordance with all applicable requirements of CFR 49, Part 236 and the recommendations of the AREMA C&S Manual, Part 8.1.20. When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

1.04 SUBMITTALS

A. Product Data: Manufacturer's catalog cuts, material specifications, installation and maintenance instructions, and other data pertinent to the bonding material, staples, and circuit connections, specified herein and as shown on the Contract Drawings.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Rail Head Bonds: Railhead bonds shall be 3/16-inch in diameter with steel terminals welded to the conductors. They shall have a nominal length of 6 1/2 inches.

B. Web Bonds: Web Bonds shall be 3/16-inch, 12-inch long welded to the web.

C. Track Circuit Rail Connectors: Track circuit connectors shall be 3/16-inch stranded bronze conductor, 1-inch tap for welded connection on one end and compression sleeve on the other end for a direct crimp type connection to the track wire, and shall have a nominal length of 4 inches. Use no crimped connections on fouling

wires or frog bonding unless authorized by the PCJPB Manager of Signals and Communications through the Engineer.

D. Bond Strand: Bond strand for fouling wires shall be 3/16-inch single strand with 1/16-inch black PVC insulation.

E. Acceptable Manufacturers:

1. Erico International Corporation or Engineer approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION OF WELDED BONDS

A. Install welded bonds at all non-insulated rail joints within the limits of this Contract that are not equipped with a bond.

B. Grind clean with a vitrified grinding wheel the surfaces of the rails where the bond is to be applied. After grinding, clean surface with an approved non-toxic solvent to remove all traces of grease and dirt. After the surface has been ground and cleaned, weld the bond wire to the rail in a manner that will ensure a thorough mechanical and electrical connection.

C. Before beginning work on these bonds, weld in the field, under conditions similar to those of the regular installation, not less than three complete bond connections, and as many more as the Engineer considers necessary to determine that the welds are being made satisfactorily. Such welds shall be subject to inspection and testing by the Engineer and acceptance of the method and quality of workmanship will depend on the results of these inspections and tests.

D. Ensure that each bond connection is thoroughly welded to the rail. The Engineer reserves the right to require a test of each weld by hammer and striker, or in any other manner, which in the opinion of the Engineer is reasonable.

E. Remove any welded bond installed by the Contractor that is found to be defective prior to acceptance, and install a new bond.

F. Ensure that track bonds are easily disconnected and can be pulled outside of the maintenance of way equipment.

3.02 INSTALLATION OF TRACK CIRCUIT CONNECTIONS

A. The plug end of the track circuit connector shall be as specified herein, at a maximum distance of 3 inches from the end of the insulated joint.

B. Strip back underground cable a sufficient distance for the exposed conductor to be fully inserted into the compression sleeve. Then compress sleeve with the type of compression tool designed for that purpose.

C. Track wire installation shall conform to PCJPB Standards.

D. All track circuit connections shall be installed by the Contractor. Remove any found to be defective prior to acceptance, and install a new track circuit connection.

3.03 TESTING

A. Test all track circuits for continuity of circuit and ensure main line track circuit is de-energized with 0.06-ohm shunt at any point within the track block.

END OF SECTION

SECTION 18450
SIGNAL GROUNDING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for a grounding system for the equipment shelter and all other wayside equipment apparatus.

1.02 REFERENCE STANDARDS

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

1. Communications and Signals Manual of Recommended Practices (C&S Manual). When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

B. ASTM International (ASTM):

1. B8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

C. National Fire Protection Association (NFPA):

1. 70 National Electrical Code (NEC)

1.03 SUBMITTALS

A. Submit Schematic Drawings showing the design and detail of the proposed grounding system for the signal and power equipment proposed to be furnished and installed.

B. Submit catalog cuts or drawings showing the type of components to be used for the proposed grounding system(s).

C. Submit Installation and Test Procedure proposed for all equipment grounding.

D. Submit test reports.

1.04 QUALITY ASSURANCE

A. Materials and equipment furnished and installed under this Section shall conform to all applicable State and local ordinances pertaining to electrical power installations and the National Electrical Code (NEC).

PART 2 – PRODUCTS

2.01 GENERAL

A. Ground rods shall be copper-clad stainless steel, in accordance with AREMA C&S Manual Part 11.3.4. The rod shall be at least 10 feet in length and at least 3/4-inch diameter.

B. Ground rod clamps shall be made of a cast bronze clamp body, with non-ferrous set-screws in accordance with the recommendations of AREMA C&S Manual Part 11.3.4.

C. Internal ground wire, from the equipment to the ground bus, shall be insulated No. 6 AWG standard copper wire in accordance with the recommendations of AREMA C&S Manual Part 11.4.1. Insulated ground wire shall be colored green.

D. Provide a grounding bus of nickel-plated hard drawn pure copper in the equipment shelters.

E. Bare Ground Wire: Soft drawn copper, Class A or Class B stranded, shall meet the requirements of ASTM B8. Sizing of ground wire shall be in accordance with the NEC, except where sizes specified herein or shown on the Contract Drawings are larger than those required by NEC; UL listed, Label A for lightning protection conductors. Grounding cable shall be continuous without joints or splices throughout its length.

F. Bolted Grounding Connectors: Use connectors made of high strength electrical bronze, with silicon bronze clamping bolts and hardware in accordance with AREMA C&S Manual Part 11.3.4; designed such that bolts, nuts, lock washers, and similar hardware which might nick or otherwise damage the ground wire, shall not make direct contact with the ground wire.

2.02 MATERIALS

A. Ground rods: As manufactured by Copperweld Corp. or Engineer approved equal.

B. Ground wire as specified herein.

C. Cadweld connections: As manufactured by Erico International Corp. or Engineer approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Ground the following as described herein and in accordance with the applicable requirements of the National Electrical Code (NEC) and local city electrical codes: Service equipment, motor frames, switchgear and equipment enclosures, lighting and power panelboards, transformers, raceways, fences and gates, building or structure steel frames, lighting standards, floodlight poles, and power/light pullboxes/maintenance holes.

2. The grounding system shall preclude any closed loop grounding arrangements.

3. Do not ground connection(s) to the track rails; do not use the neutral conductors of the ac power supply.

4. Grounding under these specifications shall conform to AREMA C&S Manual Part 11.4.1. In cases where these instructions differ, the Engineer will make final decision.

5. Ground wire/cable runs shall be as short and straight as possible and shall not be interrupted by any device.

B. Exterior: Equipment Shelter Grounding

1. At equipment shelters, drive four ground rods into the ground, one near each corner of a structure. At equipment cases, drive two ground rods into the ground, at opposite corners of the structure. The ground rods shall be a minimum of 6 feet apart and shall be driven below ground level. Dig a 12 inch deep trench between the ground rods. Electrically connect each of the ground rods connected to the others, using a No. 2 AWG bare stranded copper cable, welded using "Cadweld" or an equivalent thermal process. Coat Cadweld connections with epoxy resin. Place the ground wires in the bottom of the trench. Backfill trench, returning the soils removed during construction of the trench.

2. Cadweld shelter's copper ground cables to the ground rods.

3. Ground resistance, as measured by the "Fall-Of Potential" method, shall not exceed 15 ohms.

4. Where flexible conduit is used, provide a bonding jumper.

C. Interior: Equipment Grounding

1. Equip shelters with a prime ground terminal securely attached electrically to the shelter structure and to the made ground network.

2. Run ground connections from lightning arresters and equipment chassis separately to ground buses in the shelters, as shown on Contract Drawings. Connect ground buses to the prime ground with green insulated No. 2 AWG stranded wire.

3. Properly ground equipment that is powered by or switches voltages greater than 35 volts ac or dc.

4. Properly ground equipment that has conductors that leave the shelter.

3.02 TESTING AND INSPECTION

A. Ground Resistance Testing: Verify that resistance between ground buses and absolute earth, as measured by the "Fall-Of Potential" method, does not exceed 15 ohms without benefit of chemical treatment or other artificial means.

B. Test Reports: Provide test reports to the Engineer upon completion of ground tests that completely describe ground resistance test procedures and test results. Test reports shall be signed by a technician and witnessed by a representative of the Engineer.

C. Prior to final acceptance by the Engineer, the Contractor shall have the new ac power service inspected by state and local jurisdictional authority(s) as required.

END OF SECTION

SECTION 18500
SERVICE METERS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for 120/240, 100A three-wire, single-phase meter service and upgrading existing meter service to 120/240, 100A, 3-wire, single-phase meter service.

B. Provide all interface with and in conformance to the standards of the power provider, in order to obtain the commercial metered power service at the locations shown on the Contract Drawings and as required by the Engineer.

1.02 REFERENCE STANDARDS

A. National Fire Protection Association (NFPA):

1. 70 National Electrical Code (NEC)

1.03 SUBMITTALS

A. Submit Meter Service Drawings, indicating mounting pole, meter base, breaker box, and grounding.

B. Submit Peak load calculation for each meter location. Submit load calculation within 90 days of Notice to Proceed.

C. Submit letter certifying that the installation of the meter service has been approved by the local electrical inspector.

1.04 QUALITY ASSURANCE

A. Electrical service shall conform to the provisions in NFPA 70 National Electrical Code and these Specifications.

B. Materials and equipment furnished and installed under this Section shall conform to all applicable State and local ordinances pertaining to electrical power installations, and the National Electrical Code (NEC).

PART 2 – PRODUCTS

2.01 MATERIALS

A. Circuit Breakers

1. Circuit breakers shall be sized by the Contractor for the projected loads. Circuit breakers for 120 Vac power shall be 2 pole rated for 240 Vac. Panels shall contain 25 percent spare circuit breaker space.

2. One double pole circuit breaker shall be provided for future use, in addition to the 25 percent space circuit breaker space, specified herein.

B. Meter Bases: Shall meet the requirements of the power provider.

C. Ground Rods and Ground Rod Clamps: Ground rods and ground rod clamps shall meet the requirements of Section 18450, Signal Grounding, and those of the power provider.

D. Wood Poles: Shall meet the requirements of the power provider.

E. Meter Pedestals and Bases: Shall meet the requirements of the power provider.

PART 3 - EXECUTION

3.01 GENERAL

A. Make the necessary arrangements with the power provider and pay all fees in connection with having the new meter service hooked up at least one month prior to placing signal system in service.

B. Arrange to obtain the service connection from the power provider. Pay the power provider charges for this service connection.

C. Where the Contract Documents specify that the Owner will make arrangements with the power provider, Contractor shall be responsible for installation and coordination with the power provider.

3.02 COORDINATION

A. Coordinate the connection and interface of new cables and equipment with the power provider in accordance with its standards.

3.03 INSTALLATION

A. The installation of the various equipment and materials for the signal power distribution system that are specified herein shall be in accordance with the power provider requirements and the NEC.

B. The requirements included within this Section shall cover all incidental installation work necessary to effect an integrated, tested, and operable signal power system for the Work as shown on the Contract Drawings.

C. Arrange utility power service at all equipment shelter locations requiring such services. Connections to equipment shelters from meter may be by underground or aerial connection. Where aerial connection is used, maximum aerial length between meter and shelter shall not exceed 125 feet without the Engineer's prior acceptance.

D. In collaboration with the Engineer, meet as necessary with LPC representatives to negotiate for the upgrade, relocation, or addition of the power provider required power services needed to complete system operation.

3.04 GROUNDING

A. Meter service grounding shall be in accordance with Section 18450, Signal Grounding, the NEC, and the power provider requirements. If there is a conflict between the above specifications, the power provider requirements shall govern.

3.05 TESTING AND INSPECTION

A. Simulated load tests, in accordance with approved signal power system test procedure, shall be satisfactorily completed prior to final connection of signal facilities at each equipment location.

B. Prior to final acceptance by the Engineer, obtain inspection of the new AC power service by state and local jurisdictional authority(s), as required.

END OF SECTION

SECTION 18600

SIGNAL SYSTEMS TESTING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for tests and inspections to demonstrate that systems, subsystems, assemblies, subassemblies, and components supplied and installed under this Contract are in compliance with these Specifications and with all applicable regulatory requirements.

1.02 REFERENCE STANDARDS

A. Code of Federal Regulations (CFR), Title 49, Subtitle B, Chapter 2:

1. Part 234 Grade Crossing Safety

2. Part 236 Rules, Standards, and Instructions Governing the Installation, Inspection, Maintenance, and Repair of Signal and Train Control Systems, Devices, and Appliances

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

1. Communications and Signals Manual of Recommended Practices (C&S Manual). When following recommendations of AREMA, substitute the word "should' with 'shall".

1.03 TEST SYSTEM DESCRIPTION

A. It shall be understood where this Section states "as authorized by the PCJPB Signal Manager or PCJPB Signal Engineer" or "submit to the PCJPB Signal Manager or PCJPB Signal Engineer" such authorization or submittal shall be through the Engineer.

B. Tests and inspections shall be made both during the progress of this Contract and after completing installation of equipment, and shall consist of factory tests of Contractor Furnished equipment, circuit breakdown tests, wiring verification tests, continuity tests, resistance tests, voltage and current tests, applicable locking tests, operating tests, simulation tests, and other electrical and mechanical tests and inspections.

C. The work shall include all tests required to ensure proper and safe operation of all systems and subsystems, and to prove the adequacy and acceptability of the total installation specified herein. Tests to be performed shall cause each system and subsystem to be sequenced through its required operations, including imposition of simulated conditions to prove that the installation complies with all specified fail-safe requirements.

D. Each Contractor furnished component and unit of the wayside signal and highway grade crossing system shall have an inspection performed at its point of

manufacture and evidence of this inspection and acceptability shall be indicated on the item where practicable.

E. Conduct an acceptance test on all Owner furnished equipment prior to loading at the warehouse. Provide certified acceptance reports with each unit at time of delivery.

F. Work shall include costs of the Contractor's personnel and any special equipment and assistance required to conduct all tests with complete documentation.

G. Test equipment of proper type, capacity, range, and accuracy shall be supplied by the Contractor to perform required tests and inspections.

H. Test equipment used shall be in good working order and properly calibrated within 12 months of the date of the tests. If the test equipment manufacturer recommends a calibration interval of less than 12 months, the calibration interval shall be in accordance with the test equipment manufacturer's recommendation.

1. Test equipment shall display a sticker indicating its calibration date and the agency that performed the calibration.

2. Calibration of each instrument shall be certified by a recognized testing facility. Instruments with out-of-date calibrations will be considered non-certified. Tests conducted with non-certified instruments will be rejected.

I. In the event that the system does not meet requirements, necessary corrections and retesting shall be made by the Contractor. The Contractor shall successfully complete all tests and inspections possible prior to performing final in-service tests.

J. Work shall include all necessary disconnecting and reconnecting in order to perform the specified tests.

K. Signal systems test work specified elsewhere in these Specifications shall be construed as related to and inclusive with the testing described herein.

L. Field tests shall be coordinated with the Engineer. As many tests and inspections as possible shall be completed prior to the final cutover to avoid train delay, inconvenience to the travel public, and cost to the Owner. The Contractor shall place systems in-service in phases where possible, thus reducing the actual cutover period.

M. Tests shall ensure conformance with CFR 49, Parts 234 and 236, and shall be recorded on forms provided by the Engineer and signed by the Contractor's Signal Engineer directing each test and inspection.

N. Tests and inspections shall conform to the PCJPB's Test and Maintenance Manual. Three copies of this Manual will be provided to the Contractor at the Pre-Construction meeting. Refer to Section 01200, Meetings. The Contractor shall request guidance from the Engineer where the test and inspection requirements written herein conflict with the PCJPB's Test and Maintenance Manual.

O. Testing, including pre-testing, shall include operating all switch machines and lighting all signals. The use of lamp simulators in lieu of, or in parallel with signal lamps will not be allowed in pre-testing. An exception may be authorized by the PCJPB Signal Manager or PCJPB Signal Engineer where a signal or switch machine is in service and will be reconfigured for final cutover, or cannot be installed or wired until final cutover.

P. An appropriate meter shall be used when testing circuits. Visual observation of a relay is only valid when coil voltage or current or contact voltage, as applicable, is also measured.

Q. Test and inspection procedures shall be subject to the PCJPB Signal Manager or PCJPB Signal Engineer's acceptance and shall comply with all regulatory requirements and the manufacturer's recommended test procedure.

R. Notify the Engineer in writing at least 48 hours prior to each field test. No part of the signal system shall be placed in service without an authorized representative of the Engineer being present and witnessing the in-service tests.

1.04 SUBMITTALS

A. Submit the following pre-test information to the Engineer for acceptance:

1. Submit a Pre-testing authorization request 15 days in advance of proposed pre-testing. Such request shall include:

    a. Names of Contractor's Signal Engineer in charge of pre-testing.

    b. Other personnel assigned to the pre-test who will be performing the tests or assisting with the tests.

    c. List the assigned location(s) of the Contractor's personnel and their designated duties during the pre-test.

    d. An outline of the tests to be performed on each type of component, unit, or system, together with samples of the corresponding test records. The outline shall be arranged to indicate the proper sequence of each test to be performed on each component or unit. In addition, the date and time will be shown for each test.

    e. Description of each test to be performed, including the operating parameter to be tested. Test equipment to be used for the test, including the model number, serial number, calibration period, last calibration date and a brief description of the purpose of the test equipment.

    f. Description of equipment to be used for communication purposes.

2. Schedule of pre-testing Contractor proposes to perform which includes beginning and ending dates, times, and locations in a time-line format.

3. Identify any test or operation that may disrupt or disarrange the existing signal circuits or systems. Include description of proposed safety provisions and back-up contingency plans.

B. Submit the following in-service testing information to the Engineer for acceptance:

1. Submit, 30 days in advance of any in-service testing, a detailed cutover and in-service test procedure. This procedure shall indicate the Contractor's personnel involved, their assigned location, and responsibility during the in-service testing. Include the following for Contractor-directed signal cutovers (the following does not apply to Owner–directed signal cutovers): The test procedure shall adequately reflect the test to be performed and the sequence in which the tests shall be performed. A signal aspect chart indicating the appropriate signal aspect to be displayed as train simulation tests are made shall be included. The signal aspect chart shall indicate the progressive down grading of signals and track codes and shall reflect the resulting signal aspect displayed as a result of a light-out condition.

2. The test procedure shall include an outline of the tests to be performed on each type of component, unit, or system, together with corresponding samples of test record forms and cards. The outline shall be arranged to indicate the proper sequence of each test to be performed on each component or unit; the numbers of each type of component or unit to be tested to demonstrate adequacy of design and quality control; and a line diagram showing the grouping and sequencing of system and subsystem

C. Contractor's testing procedures and cut-over plan must pass the PCJPB Signal Manager or PCJPB Signal Engineer's and the Operating Railroads review. Contractor shall allow 30 days for this approval process.

D. Record the results of each test, as herein specified, and submit copies of the field test reports to the Engineer immediately at the completion of the cut-over testing. Prepare final type-written test reports as indicated herein and submit to the Engineer within five (5) days after the completion of each test. Final Type-written test reports shall include complete details of the test results and corrections or adjustments performed or which remain to be completed. The type-written test reports shall be signed and dated by the Contractor's responsible employee. Furnish certified test results for tests performed by any subcontractors, when such tests are required within these Specifications.

E. Where required in this Section, submit test results on completed PCJPB test record forms.

F. Submit test reports for any additional tests required by the Contractor to ensure the safe operation of the system to the Engineer.

G. Upon completion of all tests, submit a letter certifying that all tests necessary to comply with all current regulatory requirements of these specifications have been performed.

1.05 QUALITY ASSURANCE

A. The Work and testing shall comply with the following standards and regulatory requirements: AREMA Communications and Signals Manual, Part 2.4.1 and CFR, Title 49, Parts 234 and 236. When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

PART 2 – PRODUCTS

2.01 SITE TEST INSTRUMENTS AND EQUIPMENT

A. Test instruments and equipment necessary to conduct the tests specified herein shall be available, ready for use not less than one week in advance of test need. "Ready for use" shall mean properly matched for test parameters, properly calibrated, sufficiently supplied with leads, probes, adapters, stands, and similar items necessary to conduct the particular test in a completely professional manner.

2.02 TEMPORARY TEST MATERIALS

A. Temporary or interim test related materials, special tools, connections, jumpers, and similar items shall be furnished and available not less than one week in advance of the test need.

2.03 FACTORY TESTS AND INSPECTIONS

A. All wiring and equipment shall be checked to verify conformance to the Contract Drawings and the Specifications.

B. Each control point, intermediate signal, grade crossing warning system shelter or any other signal equipment shelter shall be tested to verify that it functions properly before it is shipped to the field for installation. These tests shall involve connecting all control systems (excluding signals, switches, and similar equipment) that make up a control point, intermediate signal, grade crossing warning system shelter, or any other signal equipment shelter; applying power; and then exercising each function of the system and verify proper result.

C. Confirmation shall be provided by the Contractor that all required factory tests of Systems, sub-systems, assemblies, sub-assemblies and components supplied under this Contract have been performed. Each component and unit shall be inspected at its point of manufacture and evidence of this inspection and acceptability shall be indicated. Certified test reports shall be furnished.

PART 3 - EXECUTION

3.01 FIELD TEST PROCEDURES

A. Perform as many pre-tests as possible in advance of in-service testing. Include, at a minimum, the adjustment of tunable joint couplers, microprocessor based coded track circuits, verify signal aspects against received and transmitted codes. Verify operation of, calibrate grade crossing prediction units, and adjust grade crossing signal control equipment as required to assure proper operation. In order to have a

successful cut-over, it is essential that as much pre-testing and advance wiring be completed on the Main tracks before in-service testing begins.

1. Condition precedent for in-service testing and cut-over will be the completion of pre-testing and the PCJPB Signal Manager or PCJPB Signal Engineer's acceptance of the results. Complete pre-testing and submit the results to the Engineer not less than one (1) week prior to the proposed cut-over date.

B. The field tests performed shall cause each installed system and subsystem to be sequenced through its required operations, including the imposition of simulated conditions, to demonstrate that the installation complies with all specified fail-safe design requirements and operational functions.

C. Demonstrate the quality of installation by field tests for continuity, insulation resistance, resistance of ground connections, circuit breakdown, visual inspection, and any other tests required by these Specifications. Perform these tests prior to any operational testing of systems or subsystems.

D. The Contractor's test procedures shall consist of preprinted data sheets or inspection forms. Where applicable, results of test results shall be recorded on PCJPB forms. These forms will be provided by the Engineer. When completed by the field test personnel and checked for accuracy and completeness, submit the sheet as the test report.

E. When tests require specific meter or test instrument readings, the preprinted data sheet shall show the allowable range of values, for each part of the test. The test report shall also contain a check off system for each action and a blank space adjacent to the expected value in which to record the test readings.

F. All test reports shall be dated and signed by the responsible employee of the Contractor or subcontractor on the day the test is performed. Space also shall be provided for the signature of the witnessing inspector.

G. The report shall show the specific test instruments used on each test, with instruments identified by name, type, serial number, calibration date, and calibration due date.

H. Should an error be discovered during field testing due to field wiring and connections that do not agree with the accepted circuit plans, the Contractor may correct such errors without prior acceptance of the Engineer. The Contractor shall not, however, make any changes that deviate from the Contract Drawings without prior written acceptance of the Engineer.

I. The Engineer will make all final determinations as to whether only a part, or the whole test, shall be rerun when any specific field test does not meet the requirements specified for the test.

J. Any changes made after completion of test procedure shall be re-tested in accordance with the applicable test procedure and regulatory requirement.

3.02 GENERAL FIELD TESTS AND INSPECTION

A. Perform general field tests including the tests listed herein.

B. Ground verification test.

C. Dielectric Breakdown test of all vital circuitry.

D. Wiring verification of all non-vital circuitry.

E. Vital function tests.

F. Operating tests.

G. All applicable tests prescribed by AREMA C&S Manual Part 2.4.1, where the AREMA inspections and tests do not conflict with the requirements of these Specifications

H. All applicable tests as required to ensure systems comply with CFR 49, Parts 234 and 236.

3.03 SPECIFIC FIELD TESTS AND INSPECTION

A. Perform specific field tests listed herein.

B. Grounds:

1. Ground resistance shall be tested and reported as described in Section 18450.

2. All low voltage dc circuits shall be tested to verify that they are free of grounds.

3. Contractor shall record test results on the appropriate PCJPB form and submit this completed form to the Engineer in order to obtain acceptance of this test requirement.

C. Insulation Resistance:

1. Insulation resistance tests shall be made between all conductors and ground, and between conductors in each cable in accordance with FRA rule 236.108. The insulation resistance of wires and cables installed by the Contractor shall provide an "infinite" reading when using a direct reading instrument (megger) having a self-contained source of direct current test voltage. The megger scale shall have a minimum range of zero to 20 megohms and be rated at 250 volts minimum and 650 volts maximum.

2. All insulation tests shall be performed after the equipment and cables are installed in the field.

3. Contractor shall record test results on the appropriate PCJPB form and submit this completed form to the Engineer in order to obtain acceptance of this test requirement.

D. Vital Relays:

1. All dc vital relays shall be tested for pick-up and drop-away values. These values shall be in accordance with field requirement values stated in Table I of AREMA C&S manual, Part 6.4.1.

2. Contractor shall perform all tests required to complete the appropriate PCJPB form.

3. These tests shall be performed at the shelter locations after the shelter has been set.

4. Contractor shall record test results on the appropriate PCJPB form and submit this completed form to the Engineer in order to obtain acceptance of this test requirement.

E. Energy Distribution: Energy-Off Tests: With all power to the signal instrument shelter or wayside case off, the following checks and tests shall be performed. These tests shall include:

1. Removing all fuses.

2. Verifying that circuit breaker size compares to that of Contract Drawings.

3. Comparing wire gages with those called for on the Contract Drawings. All discrepancies in wire sizes shall be replaced with the proper size wire.

4. During energy distribution breakdown, a wire count on each terminal, relay contact, etc. shall be taken to ensure that only the number of wires called for on the Contract Drawings is present at each terminal, relay contact, etc. Any discrepancies found shall be corrected and additional wires, if found, shall be removed.

5. Verify proper system voltage for each power supply, ac and dc.

6. Verify all power supplies for correct setting quantities.

7. Verify that no cross, shorts, or grounds exist.

8. Tags shall be verified for proper nomenclature and terminal location.

F. Breakdown of Control Circuits:

1. All circuits shall be tested in their entirety for the correct operation of and response to each contact on each circuit element, such as relays and contactors. Where parallel paths exist, the tests shall validate each path, and circuits shall be opened when required to ensure the proper test.

2. Each circuit shall be tested by simulating all operating conditions to verify that the circuit operates in accordance with the Specifications and accepted plans.

G. Electric Switch and Lock Movements (when applicable):

1. Continuity checks of field wires to switch-and-lock movements to verify all nomenclature.

2. Adjust throw bar so that proper tension is placed on switch points in both directions.

3. Manually operate switch machine normal and adjust lock rods and point detector rods to allow switch machine to lock up with no obstruction. Repeat above for switch machine in reverse position.

4. Turn on switch machine power, call switch machine normal and observe in field that switch machine corresponds to position called, and observe in wayside instrument shelter that proper switch correspondence relay is energized.

5. With switch machine called normal, check gaps on circuit controller contacts to see that they meet equipment specifications. Operate machine reverse and repeat.

6. Break down each contact in switch circuit controller and observe that proper switch correspondence relay drops. Repeat this procedure for both positions of the switch.

7. Place ammeter in series with motor control energy and adjust clutch such that it causes overload relay to pick up in less than ten seconds with 1/4-inch obstruction in switch point. Record current reading. Repeat for opposite position.

8. Place switch and lock movement in "hand" operation and observe switch mechanism cannot be operated by power. Place back in "motor" and verify that switch mechanism can be powered.

9. Operate switch, then shunt detector track circuit and observe that switch machine is stopped in middle of stroke and not allowed to complete movement. Remove shunt and verify switch completes movement.

10. Contractor shall record test results on the appropriate PCJPB form and submit this completed form the Engineer in order to obtain acceptance of this test requirement.

H. Signal Layouts: Tests shall be performed on all signal layouts. These tests shall include the following:

1. Continuity check of field wires and verification of all nomenclature.

2. Apply energy to signal lighting circuits and adjust all lamp voltages to 10 percent less than the lamp rating.

3. Sight signals for maximum visibility.

4. Check that light-out feature, where used, complies with FRA Rule 236.23(f).

I. Line Circuits: The purpose of this test procedure shall be to verify the integrity of line circuits between wayside instrument locations. These tests shall include the following:

1. All nomenclature shall be verified and line circuits tested for continuity.

2. Each repeater relay shall be tested to determine that it follows all the proper track relays de-energized in the signal shelters.

J. Control Office to Wayside Interface (when applicable): Upon completion of the wayside tests, a system test shall be performed to ensure continuity of operation of wayside equipment by the supervisory control system. This test shall consist of controlling all office wayside functions from the supervisory control console, and the transmission back to the control office of all indications from the field stations. The functions to be tested shall include the following:

1. Controls from Supervisory Control Console

   a. Control of switch machines.

   b. Lining of routes.

2. Indications to Supervisory Control Console

   a. Switch machine positions

   b. Track circuit occupancy.

   c. Signal indications.

   d. Power-off and alarm indications.

3. All design changes found necessary to obtain proper operation shall be submitted to the PCJPB Signal Manager or PCJPB Signal Engineer for acceptance.

K. Local Panel Test (when applicable):

1. Verify proper operation of all controls and indications.

L. Switch Circuit Controllers (when applicable):

1. Each switch circuit controller shall be tested to verify wiring, mechanical connectors, point obstruction, and point detection in accordance with AREMA C&S Manual, Part 12.5.1.

2. Contractor shall record test results on the appropriate PCJPB form and submit this completed form to the Engineer in order to obtain acceptance of this test requirement.

M. Track Circuits:

1. Each track circuit shall be tested for shunting sensitivity and polarity in accordance with the AREMA C&S Manual, Part 8.6.1.

N. Insulated joints:

1. Each insulated joint installed by the Contractor shall be tested with S&C Model 324 Track Circuit Short Finder, or Engineer accepted equal, and shall measure no less than 100 ohms across the joint.

O. Interlocking and Control Point Tests (when applicable):

1. A detailed list of the tests and complete test procedures shall be provided by the Engineer to establish safe and proper operation of interlockings. The Contractor shall provide the necessary personnel and equipment, along with support functions, as part of the Signal Test Crew. The test sequence shall be designed to test each function for correct performance, in accordance with these Specifications and the accepted plans. Furthermore, the test sequence shall include simulated unusual conditions to determine that the interlocking circuits will respond in a safe and desirable way.

2. The functions to be tested shall include the following:

   a. Time locking

   b. Route locking

   c. Verification of timing of time releases

   d. Indication locking (where applicable)

   e. Signal operation in accordance with route and aspect charts

   f. Interconnection with existing block signal systems

   g. Interconnection with existing interlockings. With an established direction of traffic, the controlled signal governing entrance to that particular route shall be put to stop. Traffic in the opposite direction shall not be established until a predetermined time has passed. This predetermined time shall be as indicated on the accepted plans. It shall be ascertained that time locking is effective for this test.

3. Time tests shall be as follows:

   a. Loss of shunt

   b. Time locking

   c. Flashing rate time (where applicable)

4. Contractor shall record test results on the appropriate PCJPB forms. Submit these completed forms to the Engineer in order to obtain acceptance of these test requirements.

END OF SECTION

SECTION 18700

HIGHWAY GRADE CROSSING WARNING SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes requirements for highway grade crossing warning systems.

B. Where shown on the Contract Drawings or as required to accommodate associated other work of the Contract, make modifications to the existing highway grade crossing warning systems including such work as replacing, rewiring, or relocating of existing equipment or providing new control equipment and trackside equipment.

C. Provide continuous operation of the highway grade crossing warning systems in preparation for, and during, track installation and rehabilitation work.

1.02 REFERENCE STANDARDS

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

1. Communications and Signals Manual of Recommended Practices (C&S Manual). When following the recommendations of the AREMA C&S Manual substitute the word "shall" for the word "should" in the applicable Manual Part.

B. Code of Federal Regulations (CFR), Title 49, Subtitle B, Part 2:

1. Part 234 Grade Crossing Safety

2. Part 236 Rules, Standards, and Instructions Governing the Installation, Inspection, Maintenance, and Repair of Signal and Train Control Systems, Devices, and Appliances

C. General Orders (G.O.) of the State of California Public Utilities Commission (CPUC):

1. G.O. 75-D: Regulations Governing Standards for Warning Devices for At-Grade Highway-Rail Crossings

1.03 SYSTEM DESCRIPTION

A. Furnish and install new train detection equipment, wideband shunts, narrowband shunts, tuned joint couplers, dummy loads, shunt housings, insulated joints, and track connections for designated existing crossings.

B. Provide continuous highway grade crossing warning during all phases of rail construction. Refer to Section 01011, Work Planning. At no time shall the work of the Contractor cause delay to train operation, cause an unsafe signaling

condition to exist, or reduce the effectiveness or quality of the existing or new grade crossing warning systems.

C. Provide rail bonding for new or modified rail joints or turnouts as shown on the Contract Drawings. Provide rail bonding, as necessary, to maintain existing systems during construction.

D. Protect existing signaling cabling and, where necessary, relocate existing cabling in order to prevent damage to the cabling during track installation, profiling, or grade crossing work.

E. Record the final as-built conditions of the crossing warning system for each crossing.

F. Perform and document all tests and inspections in accordance with CFR 49 regulations and these specifications.

1.04 SUBMITTALS

A. Provide submittals for highway grade crossing devices, equipment, systems, assemblies, and detailed design in accordance with the requirements of Section 18000, General Signaling Requirements.

1. Submit, for approval by the Engineer, proposed plan for providing alternate methods of crossing warning during cutover and whenever the existing automatic crossing warning devices are deactivated, altered, or modified in order to accommodate construction work. Alternate methods shall conform to applicable parts of CFR, Title 49, including Part 234, and local ordinances.

2. Alternative Foundation Design: If the Contractor proposes foundations different from those shown on the Contract Drawings, submit drawings of the type of foundations, including size and details of the galvanized anchor bolts, nuts, and washers the Engineer's approval. Include structural calculations with loadings and wind shear parameters. The Contractor’s alternate final design drawings and calculations shall be approved and stamped by a professional engineer registered in California.

B. Detailed Work Plan: The following work plan shall be coordinated with and integrated with submittals made under Section 01011, Work Planning. Submit a detailed work plan, for approval and coordination by the Engineer, prior to making the changeover from the existing crossing warning system to the new crossing warning system. The Contractor's proposed plan shall detail the amount of time the warning system will be out-of-service and the substitute warning which will be provided to allow normal railroad operations to be maintained. The Contractor’s proposed plan shall document existing CWT performance prior to performing the cutover. Changeover of control, testing, and temporary-warning procedures shall be coordinated with the Engineer.

C. Submit for approval of the Engineer a procedure plan for conducting quality assurance, component integrity, circuit continuity, circuit breakdown, and system operation tests.

D. Submit product data for products furnished under this Section.

E. Submit documentation of acceptance testing.

F. Submit test reports.

G. Submit results of pre-cutover CWT performance documentation.

1.05 DELIVERY, HANDLING, AND STORAGE

A. Package printed circuit cards separate from the constant warning time (CWT) units and all other electronic components with removable cards for shipment to the field. Protect each CWT unit and printed circuit card from damage or loss during handling and shipment.

B. Protect precast concrete foundation units during handling to avoid damage in transmit and at storage locations. Support, cushion, and stack to protect the edges of the units. Replace chipped, cracked, or damaged units.

1.06 SPARE PARTS AND SPECIAL TOOLS

A. Refer to Section 01600, Materials, for general requirements for spare parts. Furnish for spare parts a constant warning type (CWT) crossing train detection equipment cabinet complete with modules for a two-track operation, associated surge panels, and programming keypad.

PART 2 – PRODUCTS

2.01 EQUIPMENT - GENERAL

A. Furnish materials and equipment for installation and for interconnection of the highway crossing warning as indicated on the Contract Drawings and specified herein. Materials and equipment shall be the products of manufacturers regularly engaged in the production of such material and equipment and shall be the manufacturer's latest design. Signaling materials and equipment shall be of a type and model that are in standard operation on major railway systems.

B. Only those existing materials and equipment specifically identified on the Contract Drawings for re-use, relocation, or modification shall be incorporated in the highway grade crossing warning systems. Materials and equipment shall conform to the provisions of AREMA Signal Manual, except as modified in this Section.

C. Furnish trackside equipment, such as tuned joint couplers, narrow band shunts, and wideband shunts, as shown on the Contract Drawings. Furnish equipment shelters, predictors, track filters, chokes, and other equipment as shown on the Contract Drawings and as required for complete installation.

D. Refer to Section 01600, Materials, for lists of Owner-furnished equipment. Conduct and document acceptance testing of all components prior to transporting them from Owner-designated storage location.

2.02 ELECTRICAL AND ELECTRONIC COMPONENTS - GENERAL

A. Design fusing and furnish fuses and printed circuit cards, connectors, and files in accordance with Section 18000, General Signaling Requirements.

2.03 CROSSING WARNING TRAIN DETECTION EQUIPMENT

A. Furnish constant warning time (CWT) type crossing train detection equipment, terminating shunts, and arresters for the crossing configurations shown on the Contract Drawings. The CWT equipment shall be the ASO XP4 or approved equal.

B. Furnish each CWT unit complete with the basic complement of printed circuit cards and additional circuit card(s) for functions such as upstream detection, downstream detection, preemption initiation, event recording, and the like, as shown on the Contract Drawings.

C. Make CWT unit audio frequency assignments following manufacturers' application guidelines with special attention being paid to frequency versus approach length and placement of adjacent channel narrow band termination shunts. Acceptable primary frequencies in Hz are 86, 114, 156, 211, 285, 348, 430, 525, 645, 790, and 970. Constant warning time systems shall include a high frequency, AFO track circuit for the island circuit. Acceptable island frequencies are 10.0, 11.5, 13.2, and 15.2 kHz or the ASO Random Signature Island frequency.

D. Each highway grade crossing unit shall consist of a primary grade crossing CWT controller and a redundant standby grade crossing CWT controller. Provide an automatic transfer unit to transfer the approach control function from the primary CWT controller to the standby CWT controller in event of the failure of the primary unit and back to the primary unit if the standby unit were to fail. House the automatic transfer unit in the same cabinet as the CWT normal and standby controller.

E. Furnish constant warning time controller capable of detecting train movements on two separate track sections. Design CWT unit to allow selection of a different frequency for each track.

F. Constant warning time crossing train detection equipment shall be ASO XP4 or equivalent. Termination shunts shall be the CWT manufacturer’s recommended type shunt for the frequency and application used. Furnish multi-frequency selectable termination shunts.

G. Furnish termination shunts, adjustable inductors, filters, code isolation units, and the like, as recommended by the CWT controller equipment manufacturer, as shown on the Contract Drawings.

H. The placement of the crossing approach start shunts shown on the Contract Drawings is based upon the maximum authorized train speed of 79 MPH and a crossing warning time of 25 seconds (20 seconds minimum time and 5 seconds buffer time). Four seconds has been added to account for equipment reaction time. Additional time, if required to accommodate the individual crossings' unique characteristics or as required for traffic signal preemption requirements,

shall be as specified in the Contract Documents. Take necessary field measurements at the grade crossing and verify that the crossing warning time and shunt placement are valid for site conditions. Bring any discrepancies to the attention of the Engineer.

I. Furnish data recorder with the CWT unit capable of recording train speed, warning time, time and date, adjacent and auxiliary crossing detection times, and equipment errors. The recorder shall be capable of furnishing a report with only warning time, train speed, and time and date information and a separate report that includes error data. Internal XP4 event recorder shall be used or equivalent.

J. All application logic files shall be Owner provided.

K. All line circuits shall utilize the Fiber Optic Network.

L. Station berthing occupancy indications shall be provided for all station platforms to the supervisory control system.

M. DC and AC Power Off indications shall be provided to the supervisory control system. Power off strobe lights will not be installed on new installations.

2.04 CROSSING WARNING GATES AND FLASHING LIGHTS

A. Furnish each highway grade crossing warning device assembly complete with all associated hardware consisting of mast mounted gate mechanism, mast, junction box base, gate arm, flashing light unit(s), bell, signs, and miscellaneous hardware as shown on the Contract Drawings and as specified herein.

B. The crossing gate warning device assembly shall conform to the requirements of CPUC GO No. 75D; CFR, Title 49, Part 234; and the recommendations of the relevant sub-parts of the AREMA C&S Manual Section 3.

C. The gate mechanism housing shall be cast aluminum for mounting on a 5-inch diameter 16 feet aluminum pole and furnished complete with mounting brackets, counter-weight assembly, and counter-weights. Provide either single sided counter-weight brackets or double-sided counter-weight brackets as recommended by the manufacturer. Fit gate arm bracket with a breakaway arm adapter as shown in the AREMA C&S Manual, Part 3.2.21.

D. The gate mechanism shall be a 2-wire control WCH 3597 or equivalent.

E. Furnish gate arms lengths required per PCJPB signal standards and site conditions. Arms shall be of the aluminum with fiberglass extensions and fiberglass tip type. Gate arm lamps shall be 4-inch diameter conforming to the recommendations of AREMA C&S Manual, Part 3.2.40 except that LED lamps shall be used. Provide high intensity lamps when shown on the Contract Drawings. Fit lamp wiring harness with a five wire pull-apart connector for interconnection to the gate mechanism and securely fasten to the gate arm.

F. Provide gate arm wind guards conforming to AREMA C&S Manual Part 3.2.22 with each gate assembly.

G. Provide flashing light crossing signal units as shown on the Contract Drawings. Light units shall have 12-inch roundels with LED's and be complete with steel backgrounds, steel hoods, junction box, and cross-arm brackets.

H. Provide a crossing warning bell conforming to the recommendations of AREMA C&S Manual, Part 3.2.61 with each gate assembly, except that the bell shall be mounted on the cantilever structure when a cantilever is shown.

I. Railroad crossing signs, multiple track signs, and the like, shall be extruded aluminum, reflex-reflective sheet type as recommended in the AREMA C&S Manual Parts, 3.2.70 and 3.2.75, respectively. Signs shall have an anti-graffiti coating. Provide signs complete with all hardware for mounting on 5-inch mast or on a cantilever mast. All highway grade crossings shall conform to CPUC required signage.

2.05 FOUNDATIONS

A. Provide foundations for wayside equipment cases, highway grade crossing gates, flashers, and cantilevers as specified herein.

B. Precast or cast-in-place reinforced concrete foundations shall be monolithic or sectional construction and shall conform to the requirements for concrete work as specified in Sections 03300, Cast-in-Place Concrete, and 03400, Precast Concrete Structures.

C. Provide precast concrete foundations complete with anchor bolts, nuts, and washers in accordance with the recommendations of AREMA C&S Manual, Part 14.4.

D. All galvanized steel foundations to be furnished and installed shall be complete with Section 18360, Signal Systems Miscellaneous Products, and the recommendations of AREMA C&S Manual, Part 15.3.1.

E. Galvanized steel foundations shall be constructed of steel angle and plate welded together. Foundations shall be constructed of 2-1/2 inch by 2-1/2 inch by 1/4-inch steel angle and 1/4 inch steel plate.

F. Bolts, nuts, and washers shall be galvanized. Nuts and threads shall be in accordance with the recommendations of AREMA C&S Manual, Part 14.6.20. Plain washers shall be in accordance with the recommendations of AREMA C&S Manual, Part 14.6.21. Steel shall be in accordance with the recommendations of AREMA C&S Manual, Part 15.1.4, Section 1. Bolts shall be of sufficient length to provide for leveling of the device.

G. Place a conduit with a minimum 3-inch inside diameter in cast-in-place cantilever structure foundations for routing of cables to the cantilever junction box. The conduit shall protrude from the foundation sufficiently to enter cantilever structure ensuring cable is not exposed.

2.06 HARDWARE

A. Furnish hardware in accordance with Section 18360, Signal Systems Miscellaneous Products.

2.07 CONDUIT

A. Conduit shall conform to the specifications in Section 18360, Signal Systems Miscellaneous Products.

PART 3 - EXECUTION

3.01 GENERAL

A. Install and adjust equipment and materials in accordance with the appropriate requirements and recommendations of the equipment manufacturer, in conformance with the recommendations of the applicable parts of the AREMA C&S Manual; as required by CFR 49, Parts 234 and 236; applicable CPUC regulations; or as otherwise specified herein.

B. Where existing Grade Crossing Warning System Shelters and gate assemblies are indicated to be relocated, remove, protect, transport, store, disassemble, re-configure where necessary, reassemble and reinstall as shown in the Contract Drawings.

3.02 INSULATED JOINTS

A. Install insulated joints as specified in Section 20120, Track Appurtenances and Other Track Materials. Test each insulated joint in accordance with the requirements of the AREMA C&S Manual, Part 8.6.35, and per bonded joint and insulated joint section.

3.03 RAIL BONDING

A. Install new, or maintain existing, and test rail bonding for electrical continuity as required for continuous train detection within the approach limits of the crossings.

B. Double bond frog assemblies, switch points, and rail joints as specified in Section 18400, Rail Bonding, with the type of bonds specified in Section 18400, Rail Bonding.

C. Make signal connection to rails using weld type track circuit connectors per PCJPB standards.

3.04 CROSSING WARNING SYSTEM

A. Install, connect, and test new equipment and cabling to the greatest extent practicable without disruption of the existing highway grade crossing or signal systems.

3.05 TRACK CIRCUITS

A. Install and adjust all track circuits in accordance with the requirements of CFR49, Parts 234 and 236, the recommendations of AREMA C&S Manual, Parts 8.6.1, and as specified herein.

B. Make all track circuit rail connections using weld type connectors.

C. Adjust each track circuit for a detection sensitivity of 0.06 ohm throughout the length of the track circuit, including within the shunt fouling limits of turnouts.

D. Record voltage and current measurements at both feed and receive ends of each track circuit in a format approved by the Engineer.

3.06 HIGHWAY GRADE CROSSING EQUIPMENT

A. Install grade crossing warning equipment in conformance with CFR, Title 49 Part 234; CPUC G.O. 75D; approved submittals; and as shown on the Contract Drawings.

B. The final voltage adjustment and alignment of the flashing light units and final balancing of the gate arms shall be made at the time of the functional test. Final adjustments and alignments shall be made in conformance with the requirements of CFR 49 Part 234 and the recommendations of the AREMA C&S Manual, Parts 3.3.1 and 3.3.5 and.

C. Provide new cabling between the wayside gate/flasher and the crossing control shelter except where the Contract Drawings specifically specify the re-use of the existing cabling.

D. Install Owner-furnished/Contractor -furnished pedestrian gates in accordance with the Contract Drawings and installation instructions furnished by the Engineer.

3.07 FOUNDATIONS

A. Excavate, backfill, compact, and clean-up excavation as specified in Section 02300, Earthwork.

B. Install each foundation in accordance with the approved installation detail for each type of foundation and as specified herein. The absence of a specific task listing herein does not relieve the Contractor of the responsibility for providing a complete and functional installation. The installation tasks that must be completed by the Contractor are included herein.

C. Prior to placing precast foundation or constructing cast-in-place foundations, excavate completely to the lines and grades required and install crushed stone base in accordance with the requirements specified.

D. Install foundations to the lines, grades, and dimensions required as determined by the Contractor and approved by the Engineer. Install mounting bolts of sufficient length to accommodate use of leveling nuts between the base of the mechanism and the top of the foundation.

E. When placing foundations, ensure that anchor bolts have not been bent and that the threads are undamaged. Protect anchor bolt thread, washers, and nuts by applying friction tape, or other method approved by the Engineer, until such time as the wayside equipment is installed. Bring damaged anchor bolts to the immediate attention of the Engineer. Do not use damaged anchor bolts. Remove and replace damaged anchor bolts and completely or partially remove and replace foundation as determined by the Engineer.

F. Refer to Section 03170, Concrete Finishing, for requirements for finishing formed surfaces, smooth rubbed finish. Exposed poured concrete foundations shall be rubbed to obtain a uniformly smooth, clean surface of even texture and appearance.

G. Provide nonconductive material between the foundations and the mounted apparatus to prevent direct contact between the concrete and metal surfaces.

3.08 CONDUIT

A. Install conduit where shown on the Contract Drawings and as specified herein.

B. After conductors have been installed, seal ends of conduits terminating in instrument shelters, junction boxes, and equipment cases with an approved type of sealing compound.

C. Bore or jack conduit under the existing trackbed at any traverse, except that conduit may be placed under the track prior to the track renewal.

D. Place conduit to a minimum depth of 36 inches below finished grade except where specifically noted otherwise.

3.09 REMOVING, REINSTALLING AND SALVAGING EQUIPMENT

A. Relocate, reuse, modify, and salvage existing equipment as shown on the Contract Drawings. Refer to Section 02100, Demolition, for salvage requirements. Inventory existing relays and controlling equipment prior to delivering to the Engineer's designated storage location.

1. Newly re-wire any existing equipment designated to be reused except where noted on the Contract Drawings.

B. Removed equipment and materials not designated for reuse or salvage shall become the property of the Contractor and disposed of. Refer to Section 02110, Site Clearing, for disposal requirements.

C. Change existing crossing warning systems over to the new systems as expeditiously as practicable. Remove retired equipment immediately and keep work site kept free of debris and packaging materials.

3.10 FIELD QUALITY CONTROL

A. Perform testing in accordance with Section 18600, Signal Systems Testing, including documentation requirements.

B. Prepare test procedures and perform and document tests on the highway grade crossing components and systems as follows:

1. Include all tests herein specified, as specified in the FRA Rules, Standards, Instructions for Railroad Signal Systems, CFR 49 Part 234 and 236 and the appropriate sections of the AREMA C&S Manual.

2. Perform pretests on all procedures in advance of actual testing.

3. Perform applicable tests to each interim signal system, if any, before placing in service.

4. Actual testing shall be witnessed by the Engineer.

C. Make measurements at each piece of wayside equipment and record on the as-built record drawings verifying that the equipment is located where shown on the Contract Drawings and as approved by the Engineer. Verify, by measurement, that the equipment does not violate the train dynamic clearance envelope.

D. Test each grade crossing warning installation in accordance with Section 18600, Signal Systems Testing, and the AREMA C&S Manual, Parts 3.3.1 and 3.3.5. In addition, perform all applicable tests as described in the PCJPB Signals and Communications Test and Maintenance Manual, all manufacturer's recommended test and adjustment procedures, and any tests required by regulation.

E. Disconnect and ground associated signal equipment not under test. Disconnect or unplug electronic devices or signal equipment prior to any testing.

F. Follow manufacturer's instructions for testing of operation and electronic equipment.

G. Submit test data and results to the Engineer's information and approval within 24 hours of placing the apparatus or system in operation.

END OF SECTION

SECTION 19100

VOICE RADIO COMMUNICATION SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes design and installation requirements for extension, upgrade, or retrofit of the existing VHF Voice Radio System.

1.02 REFERENCE STANDARDS

A. National Fire Protection Association (NFPA):

1. 70 National Electrical Code (NEC)

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

1. Communications and Signals Manual of Recommended Practices (C&S Manual)

C. CAL/OSHA standards

D. California Public Utilities Commission (CPUC) Regulations

E. State of California Title 8 Regulations, Division 1, Chapter 4, Subchapter 5, Electrical Safety Orders

F. Federal Communications Commission (FCC) rules and regulations

G. Motorola R56 Standards and Guidelines for Communication Sites

1.03 EXISTING SYSTEM DESCRIPTION - ABOVE-GRADE SUB-SYSTEM

A. Caltrain railroad consists of approximately 78 miles of railroad tracks serving freight and passenger operations between San Francisco and Gilroy. The railroad dispatch, operations and maintenance are served by a VHF Voice radio system which is configured as follows:

1. The VHF Voice Radio system consists of four distinct radio channels: The Northern Territory Road channel and the Southern Territory Road channel used to support train movement; a Maintenance of Way (MOW) channel used to support Operations and the Mechanical department; and a Yard channel (aka Blue Flag). The Northern and Southern Territories Road channels are analog, FM, narrowband (12.5 KHz) simplex channels operating on a frequency of 160.8150 MHz and 160.485 MHz respectively. The MOW channel is an analog, FM, narrowband (12.5 KHz) full duplex channel operating on the frequency pair: 161.5050 MHz for Base Station transmit and 160.5750 MHz for Base Station receive. The Yard channel is an analog, FM, narrowband (12.5 KHz) simplex channel, configured for independent local operation at the San Jose CEMOF and San Francisco 4th Street train yards.

2. A total of two independent dispatch work stations are located at the CEMOF, San Jose Centralized Control Facility (CCF). One of the two dispatch stations is responsible for supporting the "Northern" portion of the railroad, between MP (mile post) 0.0 and 44.0, and the second station supports the "Southern" portion of the railroad between MP 44.0 and 55.0 on the Road channel. Between MP 55.0 and the southern end of the railroad, train movement is controlled by the Union Pacific Railroad (UPRR). Although each dispatch station is "stand-alone" or independent of the other, they are also fully redundant to each other, since they are individually capable of supporting rail vehicle movements for both the northern and southern territory of the railroad. The operation of the MOW channel at CEMOF is system wide for both consoles and is therefore not restricted to these North and South limits. The Road and MOW channels are both managed and controlled from the Voice Radio dispatch consoles located at the CEMOF control center. The Yard channel is monitored, but equipment movement is not controlled by the dispatchers.

3. A total of four "above-grade" Road Channel radio Base Station sites, which are located along the Right-of-Way (ROW), are each configured for carrier-squelch, simplex operation on the road channel frequency of 160.8150 MHz. A second carrier-squelch, simplex channel, operating on a frequency of 161.0700 MHz is used to support maintenance and "yard" operation but is repeated only in the vicinity of the San Francisco and San Jose yards using the 4th street and the San Jose Base Station towers respectively. Of the 4 Base Station sites, three are controlled by the "Northern Territory" dispatch, and one by the "Southern Territory" dispatch. Refer to Caltrain Standard Drawings SD-6000 series for further details. The MOW channel uses two "above-grade" Base Station sites located at the Monument Peak and San Bruno mountain top sites. Both Road and MOW channels also utilize four (4) "at-grade" tunnel Base Station sites, described in subpart 1.04 below.

4. The "Northern" Road Channel dispatch Base Station sites are listed in Table 1.1 below, along with their GPS coordinates.

Table 1.1 Northern Dispatch Base Station sites

SITE NAME	GPS COORDINATES	SITE ELEVATION	ANTENNA AZIMUTH
Fourth Street Tower	N 37º 46' 28.8" W 122º 23' 50.2"	65 feet (55+10)	OMNIDIRECTIONAL Gain 0 dBd
Sign Hill	N 37º 39' 53.8" W 122º 25' 14.1"	576 feet (561+15)	156º Gain 8 dBi
San Carlos	N37º 30' 23.4" W122º 15' 43.1"	106 feet (99+7)	140º Gain 8 dBi
CP Mary	N37º 22' 56.8" W122º 02' 31.4"	90 feet	Bidirectional 4-Dipole 253º Gain 8 dBi

5. The lone "Southern" Road Channel dispatch Base Station site is listed in Table 1.2 below, along with its coordinates.

Table 1.2 Southern Dispatch Base Station site

SITE NAME	GPS COORDINATES	SITE ELEVATION	ANTENNA AZIMUTH
CEMOF, San Jose	N 37º 20′ 20.28″ W 121º 54′ 29.22″	138 feet (78+60)	314º /134º Dual Yagi. Gain 10 dBi

B. In addition to the four Base Station sites described above, there are three Dragging Equipment Detectors (DED) located along the ROW at MP 11.3 (between Millbrae and San Bruno), MP 28.2 (between Menlo Park and Atherton) and MP 42.0 (between Santa Clara and Lawrence). Each of these DED sites is equipped with a VHF voice radio, configured to report wayside status to the train Engineer and the control center by transmitting this data on the same frequency as the road channel: 160.8150 MHz. More location details of the 3 DEDs are shown in table 1.3 below.

Table 1.3 Dragging Equipment Detector sites

DED NAME	GPS COORDINATES	SITE ELEVATION	ANTENNA AZIMUTH
11.3/10.8*	N 37º 37′ 42.2″ W 122º 24′ 37.0″	15 feet	Rail Tx. OMNI Gain 0 dBd
28.2	N 37º 27′ 36.4″ W 122º 11′ 25.9″	36 feet	Rail Tx. OMNI Gain 0 dBd
42.2	N37º 22′ 11.5″ W121º 58′ 27.6″	44 feet	Rail Tx. OMNI Gain 0 dBd

* This DED relocated to 10.8 in 2011

1. The DEDs are transmit-only devices, located along the ROW. They utilize a Harmon Electronics (West Coast Operations) WCO-46 "talker-system" which contains a discrete Motorola HT-440 VHF voice radio connected to a small roof mounted omni-directional antenna. Currently the DEDs transmit each time a train passed by, however this is being changed to an exceptions based configuration, in which DEDs will transmit only upon detection of a problem.

1.04 EXISTING SYSTEM DESCRIPTION - TUNNEL SUB-SYSTEM

A. The terrain between the Fourth Street and the Sign Hill Base Station sites is fairly rugged, with several small, but steep hills in the path of the railroad. In 4 such locations, the railroad tracks are built through tunnels inside these hills. Each tunnel is between 1000 and 3600 feet in length and is equipped with a small, stand-alone radio Base Station located at the south entrance to the respective tunnel. Each of the four tunnel Road-channel radio Base Stations is identical to the 4 above-grade Road-channel radio base stations except that each tunnel radio Base Station is connected to a distributed antenna system, which is installed inside each tunnel to support radio communications inside the confines of the respective tunnel. Each tunnel base station is also connected to a low profile external antenna to provide coverage to the approach/exit of the southern end of the respective tunnel. Additionally, each of the four tunnels is equipped with a MOW base station radio. The Road and MOW channels are transmitter combined and receiver multi-coupled to/from the same antenna system. Refer to

the drawings for details. The recovered audio signal from each of the four tunnel Road-channel radio receivers is sent to San Jose via separate leased-lines into a voting comparator to select the best audio signal to present to the dispatcher. The recovered audio signal from each of the four tunnel MOW radio receivers along with the two above-grade base station receivers is voted (compared using a comparator assembly, and from which the signal with the best Received Signal Strength Indicator (RSSI) is selected) in the same manner in order to select the best audio signal to present to the above-grade, wide area transmitter.

1.05 EXISTING SYSTEM DESCRIPTION - MOBILE USERS

A. Each locomotive and cab car operating between San Francisco and Gilroy is equipped with a VHF-voice mobile radio. Refer the technical specification details of the mobile radio equipment specified in Part 2 of this Section. Each mobile radio is programmed and configured to operate in carrier-squelch simplex mode on the "road" and the "yard" (aka "blue flag") channels, and carrier-squelch full duplex mode on the MOW channel. Likewise all mobile and portable radios used by Caltrain operations and maintenance personnel are programmed to operate on each of the three carrier-squelch channels.

B. During the peak commute hour, there may be as many as seventy (70) locomotive/cab car radios and two hundred (200) mobile and portable radios in use on the VHF voice radio system. They contend, along with the three DEDs for road-channel "air-time" to access the four (4) above-grade Base Station sites in order to communicate with the dispatcher. In addition, these users contend with each other and with the 3 DEDs in order to communicate with each other (only when in close proximity) using the simplex radio-to-radio mode. Similar user contention for access to the four (4) Tunnel Radio Base Stations occurs, except due to logistical reasons, no more than about six (6) locomotives and a slightly greater number of mobiles and portables radios will be within range of these four tunnel Base Station sites. The same holds true for the MOW channel, except that the number of users vying for control/use of the channel is significantly less because it is not used for dispatch.

1.06 FUNCTIONAL REQUIREMENTS

A. Footprint and Reliability: The following table defines the footprint and reliability of the cumulative VHF voice radio coverage that shall be provided by the 4 above-grade Base Stations and independently by the 4 tunnel radio Base Station sites. The radio coverage required from the dragging detectors shall be of the same quality, but limited to +/- 3 miles along the ROW.

B. Although Signal to Noise-and-Distortion (SINAD) is the only objective measure of the quality of the radio coverage, the Contractor will be permitted to test the quality of radio coverage using more expeditious measures such as Circuit Merit (CM), Delivered Audio Quality (DAQ) or Signal Strength, provided the Contractor first establishes the correlation between the measure used in the testing and the 20 dB SINAD criterion. Refer to Part 3, 3.02 "Testing" for details of the testing required.

C. All Voice Radio channels are configured for Narrowband operation. Narrowband is currently defined by the FCC (circa 2011) as occupying a channel bandwidth of 12.5 KHz with a transmitter deviation not to exceed ±2.5 Khz.

D. Frequency And Configuration: One simplex radio channel (the Road Channel) is utilized to coordinate all dispatch operations. It is broadcast along the entire ROW. A second simplex channel, the Yard (aka Blue Flag) channel is used to support maintenance and yard related activities and is only broadcast within the confines of the two "yard" locations along the ROW. The third channel, (called the MOW channel) is configured as full duplex, and, repeated along the entire ROW, as well as on most of the Peninsula and surrounding areas to serve the requirements of operations and maintenance.

Table 1.4 Radio Coverage Footprint and Reliability

LOCATION	RSSI PERCENT GEOGRAPHIC COVERAGE	RSSI MINIMUM EIA SINAD/CM/DAQ LEVEL	RSSI PERCENT OF TIME RX / TX. LEVELS ≥ MIN. LEVELS	COMMENT
Along the ROW	99	20/4/3,4	95/95	To Trains &Trackside
Within 500 feet of Trackside	95	20/4/3,4	95/95	To Portable & Mobile Radios
Inside the tunnels	99	20/4/3,4	95/95	To Trains & Trackside
Around DEDs	99 centered +/- 3 miles along ROW	20/4/3,4	95/95	Plus or minus 3 Miles along ROW

E. Dragging Equipment Detector

1. Each DED shall report wayside status immediately after the passage of a train. This report must be made on the road channel, so that it can be heard by the train Engineer, in the event that there is a problem, in which case the train can be brought to a stop immediately.

2. The report from each DED shall also be recorded, either at the CEMOF, or in equipment mounted along the ROW. The decision regarding where the DED recordings are made, shall be made on a case by case basis, with all DEDs whose RF transmissions cannot establish a viable communication link with one base station site, when the output power is reduced in order to limit the range to +/- 3 miles along the ROW, being recorded along the ROW. This requirement means that each DED, which is not recorded along the ROW, shall have a reliable communication link to at least, but no more than one Base Station site located in the Northern or Southern territory, corresponding to the location of the DED.

3. Supply Motorola HT-750 or Engineer approved equal for use as the radio interface to the dragging equipment detector.

F. Voice Recording:

1. All voice radio communications that require the use of a Base Station site must be recorded at the control center, per FRA regulations, however,

because all voice radio communication (even those localized communications utilizing the radio-to-radio mode) will be recovered by at least one Base Station site, then, in effect, all Voice Radio Communications will be recorded at the CCF.

2. The voice logging recorder shall record to a hard-disk or silicon storage drive with an analog interface to the Caltrain voice radio and telephone services. The Voice Recorder shall be capable of supporting a minimum of thirty six (36) channels. The voice recorder shall support a network storage interface, with a minimum of 5 TB of storage and a compression ratio of 6:1 or higher. Supply a NiceLog NCF3B-24 or Engineer approved equal.

G. Tunnel Base Station Sites

1. The receive audio from the four tunnel Base Station sites shall be voted and only the best quality signal from the four tunnel sites shall be presented to the Dispatch Console. The voters, which are manufactured by JLP/Raytheon, shall be compatible with the EIA (Motorola) signaling tones required to control the GE Mastr III Base Stations.

2. The tunnel radio Base Station sites shall be equipped with an external antenna system extension. This external antenna extension shall be utilized on the south end of each tunnel, with the region outside the north end of each tunnel supported by the antenna extension of the next tunnel to its north. A high gain directional antenna shall be used external to each tunnel in order to extend the radio coverage around the hilly regions adjacent to these tunnels.

H. Dragging Equipment Detectors: The transmit power of each DED shall be reduced to provide an ERP, (dependent on the terrain in the immediate vicinity of the DED) that will restrict radio coverage to provide a receive intensity of ≥ -109 dBm (≥3 watts) within a ± 3 mile region of track. The transmit ERP required to achieve this shall be determined by the Contractor based on the use of radio coverage simulations and field tests.

I. Communications Back-haul

The Communications back-haul serves to connect the CCF (located at the CEMOF in San Jose) with the various Voice Radio Base Station sites through which the dispatchers at the CCF communicate with trains and with field personnel.

The existing voice radio communication backhaul uses leased 4-Wire Point-to-Point (4W PTP) circuits from AT&T between the CCF and the following Voice Radio Base Station sites: 4th Street, Sign Hill, San Carlos and Tunnels 1 to 4.

The MOW voice radio communication backhaul uses an Agency-owned Microwave Radio network between the CCF and the following MOW Radio Base Station sites: Monument Peak and San Bruno Mountain.

The voice radio communication backhaul between the voice radio Base Station co-located at the CEMOF facility is provisioned via a twisted-pair 4-Wire circuit, less than 100 feet in length.

Refer to Caltrain Design Criteria, Chapter 6, Train Control Communication for further details of the existing voice radio communications back-haul.

J. Narrow-banding

1. History

In 1995, the FCC issued a mandate, with rules to address more efficient use of the increasingly crowded frequency spectrum. All licenses below 512 MHz were required to migrate from the default 25 KHz bandwidth to a 12.5 KHz bandwidth, within 10 years and eventually to a 6.25 KHz bandwidth within 18 years.

This timetable proved too difficult to meet, and after several stays, the FCC issued the *"Third Memorandum Opinion and Order (3rd MO&O)"* in December 2004 that set January 1, 2013 as the deadline by which all licenses operating below 512 MHz must be converted to the 12.5 Khz FCC emission designation and operation. Currently, equipment designed solely for 25 KHz bandwidth operation is no longer available, and is rapidly being replaced by equipment designed to operate on either 25 KHz or 12.5 KHz (user configurable by a minor software/code-plug change)

Notes:

a. In anticipation of this mandate, all voice radio equipment purchased/specified by Caltrain in the last 8 years is 25 KHz/12.5KHz capable.

1.07 DESIGN REQUIREMENTS

A. Design extension, upgrade or retrofit of the VHF Voice Radio System, as applicable. Design shall be in accordance with applicable FCC rules and regulations. New radio design shall be able to operate at 12.5 and 6.25 KHz.

B. Design Prerequisites: Execute and submit design of the Radio System in four iterative parts: the 30 percent, 65 percent, 100 percent, and Issued for Bid/Construction (IFB/C).

C. SCADA Interfaces: Equip Radio Base Station sites with Alarm monitoring and remote control/command interfaces that shall permit the Dispatcher at the CCF to monitor Alarm conditions at each site, as well as remotely reboot any component of the Base Station that is micro-processor based. The Base Station shall be interfaced to a SCADA system provided by others. The SCADA system shall be capable of reporting to the existing Train Control server.

1. As a minimum, the following alarms shall be provisioned:

a. Low/ Loss of RF Power

b. High VSWR

c. Loss of AC Power

d. Loss of DC Power

e. Rectifier failure

f. High Temperature

g. Door Open

h. Flooding (indoor sensors)

2. Each alarm shall be activated via a dry contact relay pair, which shall be normally open.

D. Radio Coverage Simulations:

1. Utilize computer simulations to predict the VHF voice radio coverage and traffic for all new Base Stations or DEDs added. These computer simulations shall utilize terrain and clutter data with a resolution no worse than 30 meters. Use the NAD 83 (2007) or later geodetic datum. Utilize a color gradient to display both the uplink and downlink coverage predictions, with each color representing no greater than a 10 dB gradient. Perform simulations for each of train and portable radio user types located within 500 feet on either side of the ROW.

2. In order to predict the quality of radio coverage inside tunnels, construct a Radio Frequency Link Budget, using Microsoft Excel or a similar spreadsheet program. Construct one power budget for each frequency band / user and for each direction (uplink / downlink).

3. To assure a communications reliability of 99 or 95 percent where specified, factor a fade margin of 17 dB or 10 dB respectively into all radio coverage simulations and all power budget analysis.

E. Intermodulation Studies: For all new installations with three or more transmit frequencies, or those with less than three transmit frequencies but more than two external adjacent frequencies (of power, measured internal to the new system, within 10 dB of the power of the transmit frequencies) that cannot be removed with notch filters, construct and execute an intermodulation study. This study shall examine all receiver intermodulation products created from the mixing of these transmit frequencies. For installations inside tunnels which use Bi Directional Amplifiers (BDA) in addition to the study defined above, perform a second intermodulation study which examines the mixing of multiple receive frequencies and separately multiple transmit frequencies inside an amplifier.

F. Structural Design: Provide structural design for new lattice, monopole or tilt-down towers, tower foundations, and civil structures associated with new installations required for the work of this Section. Design shall take into account specific soil types at each site. Drawings and calculations shall be signed and sealed by a Civil/Structural professional engineer licensed in the State of California. Designs shall be based on the use of a geotechnical report prepared

for the respective site(s) and shall include all calculations using maximum weights and wind loads supported by the towers.

1.08 SUBMITTALS

A. Design Submittals: Submit design documents in four phases in accordance with approved submittal schedule. Obtain the Engineer's approval of each part before proceeding to more advanced parts.

1. 30 percent design document

2. 65 percent design document

3. 100 percent design document

4. Final design document

5. Issued for Bid/Construction and As-Built drawings

The 65 percent, 100 percent, IFB/C and As-Built drawings shall, at a minimum, include the following documents:

a. Radio Coverage Simulations

b. Intermodulation Studies

c. Grounding and Lightning Protection. In accordance with requirements indicated on the Contract Drawings, submit detailed drawings depicting the grounding configuration proposed for each radio site

d. Structural Design Calculations and Drawings

e. Radio "code plugs"

f. Configuration management documents

B. Obtain Engineer's approval of any deviations from the specified design requirements. Submit request explaining the reasons for deviations and a description of the deviation itself for approval.

C. Product Data and Shop Drawings: Submit product data and manufacturer shop drawings at least 60 days prior to start of any installation.

1. Submit product data for approval for Base Station Radio, Locomotive/Cab Car Radio, Vehicular Mobile Radio, Portable Radio, and DED radio proposed by or before the 65 percent design submittal

2. Submit for approval catalog cut- sheets and other manufacturer literature and manufacturer shop drawings describing all products proposed

D. Installation Drawings: At least 60 days prior to the start of the installation of any item, submit a set of installation drawings for approval.

E. Test Plan And Procedures: At least 90 days, prior to the start of testing, the Contractor shall submit a test plan and test procedures to the Engineer for approval. The testing shall thereafter proceed only after written approval of the plan and procedures by the Engineer

F. Quality Assurance: Submit the resume of the Radio Communication Engineer for approval.

G. Operation and Maintenance Manuals, Training, And Spare Parts: Submit Operations and Maintenance (O&M) Manuals, a training plan, and a list of recommended Spare parts.

1. Submit O&M Manuals for all systems and devices provided under this Section. O&M Manual for the Radio System shall include electrical and mechanical specifications of all the components and sub-assemblies used to construct the system.

2. Training Plan: At least 60 days prior to training, submit Training Plan including Operation and Maintenance Manuals and a training outline for the approval. Submit resumes of the instructors.

3. Spare Parts List: Submit a list of recommended spare parts for Engineer approval at least 60 days prior to the start of training. Include manufacturers' prices.

H. Test Equipment and Special Tools: Submit list at least 30 days prior to start of training. Submit list of test equipment and special tools required for the optimal maintenance of the radio system provided. List shall be complete with cost quotations.

I. Cut-Over Plans: Submit cut-over plans for approval.

J. As Built drawings shall be submitted no later than 30 days after system acceptance. To ensure accuracy of the "As-Builts", a set of "red-line" as-constructed drawings shall be maintained at each site for which construction and installation work are in progress.

1.09 QUALITY ASSURANCE

A. Qualifications: Only qualified Radio Communication Engineer(s) shall be allowed for the performance of this work. Radio Communication Engineer shall be a professional Electrical Engineer licensed in the State of California, and shall have designed or integrated at least two similar projects in the last five years.

B. The Contractor shall include a Software Configuration Management document with all design documents to ensure that Caltrain maintains an accurate and documented record of all versions of "code plugs" and software deployed to support the ATCS network.

1.10 MAINTENANCE MATERIALS

A. Spare Parts: Furnish spare parts for Caltrain's use in the following quantities. For the total quantity of each powered (active) device provided, furnish 20 percent (rounded to the next highest number) as spares. For the total quantity of each passive (un-powered) device provided, furnish 15 percent (rounded to the next highest number) as spares. These spare parts shall not be used by the Contractor in correction of defective work under the Guaranty of Work.

PART 2 – PRODUCTS

2.01 PRODUCTS

The following products pertain to existing installations:

A. At a minimum, the selected radios and antennas shall meet the technical specifications listed in the following tables. Additionally Base Station, CP and DED sites shall be equipped with backup power as specified below:

Table 2.1 Base Station Radio Technical Specifications

SPECIFICATION	DESCRIPTION	COMMENT
Model	MASTR III VHF, Analog, Conventional Base Station or Engineer approved equal	
Operation	Simplex/Duplex	
Squelch Gate	Carrier Only	
Power	10-110 Watts, Adjustable	
Channel Spacing	25/30 KHz and 12.5 Khz	Refer to Contract Documents
Sensitivity (EIA 12dB SINAD)	-116 dBm	
Selectivity (EIA 2-signal)	90 dB	
# of Channels	1 TX, 1 RX	

Table 2.2 Locomotive/Cab Car Radio Technical Specifications

SPECIFICATION	DESCRIPTION	COMMENT
Model	VHF, Analog, Conventional Mobile Radio	
Operation	Simplex/Duplex	
Squelch Gate	Carrier Only	
Power	45 Watts, Adjustable	
Channel Spacing	25/30 KHz, and 12.5 Khz	Refer to Contract Documents
Sensitivity (EIA 12 dB SINAD)	-116 dBm	
Selectivity (EIA 2-signal)	90 dB	
Amount of Channels	>90	

Table 2.3 Mobile Radio Technical Specifications

SPECIFICATION	DESCRIPTION	COMMENT
Model	VHF, Analog, Conventional Mobile Radio	
Operation	Simplex/Duplex	
Squelch Gate	Carrier Only	
Power	45 Watts, Adjustable	
Channel Spacing	25/30 KHz, and 12.5 Khz	Refer to Contract Documents
Sensitivity (EIA 12 dB SINAD)	-116 dBm	
Selectivity (EIA 2-signal)	90 dB	
Amount of Channels	>90	

Table 2.4 Portable Radio Technical Specifications

SPECIFICATION	DESCRIPTION	COMMENT
Model	VHF, Analog, Conventional Portable Radio	
Operation	Simplex/Duplex	
Squelch Gate	Carrier Only	
Power	5 Watts	
Channel Spacing	25/30 KHz, and 12.5 Khz	Refer to Contract Documents
Sensitivity (EIA 12 dB SINAD)	-116 dBm	
Selectivity (EIA 2-signal)	90 dB	
Amount of Channels	>4	

Table 2.5 Dragging Equipment Detector Radio Technical Specifications

SPECIFICATION	DESCRIPTION	COMMENT
Model	Motorola VHF HT-750, Analog, Conventional Transmitter or Engineer approved equal	
Operation	Transmit Only	
Power	10 Watts, Adjustable	

Table 2.6 Antenna and Antenna Array Technical Specifications

SPECIFICATION	DESCRIPTION	COMMENT
Pointing Azimuth	Directional, as required	BASE STATIONS AND DED
Frequency	159-162 MHz	ALL SITES
Gain	As needed	ALL SITES
Impedance	50 ohms	ALL SITES
Lightning Protection	DC Ground through support mast	
Beam-Tilt	As Needed	ALL SITES
Beam-width	As needed	ALL SITES

Table 2.7 Backup Power

SPECIFICATION	DESCRIPTION	COMMENT
Backup Power	48 hours	BASE STATIONS SITES
Backup Power	8 hours	CONTROL POINTS
Backup Power	8 hours	DED

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install system in accordance with the approved shop and construction drawings and manufacturers written procedures.

B. Installers shall provide environmental protection of all outdoor installations:

1. Connectors shall have protective sleeves for weatherproofing, cabling and equipment shall be secured against strong winds, and electronics shall be mounted in NEMA 4 enclosures.

2. Waterproof all outdoor connectors into coaxial cables.

3. Where antennas or other equipment are mounted on towers or poles, installation designs shall be stamped by a registered Civil/Structural Engineer, licensed in the State of California to ensure equipment does not exceed the maximum load of the tower or pole.

3.02 TESTING

A. Thoroughly test all installations and thoroughly document tests. Test radio system to ensure that the minimum RF coverage requirements specified herein are met.

B. Test Plan:

1. Prepare plan which shall, at a minimum, define the types of tests to be performed, the sequence of these tests, as well as any conditions that would require any changes to the amount, type or sequence of said tests. In addition, identify the personnel and protocol responsible for the execution, witnessing, and acceptance of these tests.

2. At a minimum, include in the test plan and develop detail test procedures for the following categories of tests:

   a. Factory Acceptance Tests (FAT)

   b. Site Acceptance Test (SAT)

   c. Miscellaneous Field Tests

   d. Radio Coverage Tests

   e. System-wide Field Acceptance Tests (SWFAT)

C. Perform all required Factory Acceptance Tests (FAT), Field Tests, (which may include ground resistance tests, battery capacity tests and site alarm tests), Radio Coverage tests and System-wide Field Acceptance Tests (SWFAT), in accordance with the approved Test Plan. All test plans and procedures involving the railroad ROW, or affecting an active signal or communication system shall follow the Site Specific Work Plan (SSWP) process.

D. Perform Factory Acceptance Tests for all components, subsystems or subassemblies that are manufactured independent of other subsystems or subassemblies. Notify the Engineer when Factory Acceptance Tests are performed sufficiently in advance of tests to give the Engineer the opportunity to witness tests. The Engineer may, at his sole discretion, elect to waive some of these FATs.

E. Perform miscellaneous field tests on any component, subsystem or subassembly that is required to be put into service prior to the completion of the SWFAT. These may include ground resistance tests, battery capacity tests and site alarm tests.

F. Perform Radio Coverage testing for all portions of the ROW. Test coverage to/from trains moving along the ROW on the downlink paths, using a computer-controlled measurement and recording device that continuously monitors and records the RF signal levels that would be measured by a train radio as it travels the length of the ROW. Since the reverse process of measuring the uplink signal strength is considerably more difficult, the Contractor may utilize a combination of sample uplink signal strength measurements, along with a correlation, which shall be computed by the Contractor, between the measured downlink signal strength and the expected uplink signal strength from the same location pair.

Additionally, in order for measured signal strength to be used as the predictor of signal quality, the Contractor shall derive a correlation between the measured signal strength to be used as the pass/fail criterion and 20 dB SINAD. This

derived mathematical relation shall also be supported by sample measurements of 20 dB SINAD and signal strength in 5% of the test locations to confirm the correlation. The Contractor shall prepare and submit the derived uplink/downlink correlation, as well as the derived 20 dB SINAD/signal strength correlation to the Engineer for approval at the same time that the test procedures are submitted for approval. The sample measurements shall be taken at the start of testing, and if necessary, the models tuned until the correct correlations are confirmed. Correlations between 20 dB SINAD and DAQ 3.4 or CM 4 will also be considered in lieu of signal strength. If the Contractor proposes to use such correlation analysis, submit it to the Engineer for review and approval.

G. Conduct System-wide Field Acceptance Testing (SWFAT) in all areas where the radio coverage or radio equipment interfaces to users or other subsystems. Conduct these tests only after the radio system is placed in its final configuration and interfaced to all other systems with which it is expected to interact during normal operations. The tests shall fully demonstrate the operation of all the radio sites, Base Stations, and equipment as a single system, capable of meeting all of the coverage, reliability and other specification parameters defined herein.

3.03 CUT-OVER

A. Prepare cut-over plans, where applicable. Prepare a cut-over plan for all installation work along the ROW as well as at remote Radio Base Station sites, irrespective of whether or not this work is scheduled for revenue or non-revenue hours. Plans shall clearly and thoroughly define the required sequence of activities, including staging, installation and testing of all materials and subsystems, in such a way as to minimize interruption to the Owner's revenue system and other railroad operations.

B. Execute approved cut-over plan.

3.04 TRAINING

A. Provide a training program for Caltrain and their Operating Railroad of Record personnel at least 4, but no earlier than 13 weeks, prior to the completion of the final acceptance testing. Training shall be tailored for Maintenance and Operations personnel, and training material specific to these two groups shall be designed and provided. Duration of training as well as the class size shall be as specified in the Contract Documents.

B. The following are the minimum required items in the course outline:

1. Prerequisite Mathematics

2. Prerequisite Background/Introductory material

3. Detailed System Description

4. System Tolerances

5. System Troubleshooting

6. As-Built Drawings of Radio System

7. Configuration Management plan

END OF SECTION

SECTION 19200
ATCS DATA RADIO NETWORK AND
PTC RADIO

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes requirements for extension, upgrade, or retrofit of the existing ATCS Data Radio Network design and installation.

1.02 REFERENCE STANDARDS

A. National Fire Protection Association (NFPA):

1. 70 National Electrical Code (NEC)

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

1. Communications and Signals Manual of Recommended Practices (C&S Manual)

C. CAL/OSHA standards

D. California Public Utilities Commission (CPUC) Regulations

E. State of California Title 8 Regulations, Division 1, Chapter 4, Subchapter 5, Electrical Safety Orders

F. Applicable Federal Communications Commission (FCC) regulations

G. Motorola R56 Standards and Guidelines for Communication Sites

1.03 EXISTING SYSTEM DESCRIPTION - GENERAL

A. The Advanced Train Control System (ATCS) is a radio communication network, including a network protocol that is used in support of the Centralized Traffic Control (CTC) system.

B. The ATCS is a network of Base Station radio and Control Point radio sites implementing a Non-Vital Supervisory Control System in support of all train movement along the Peninsula Corridor. This supervisory control system is implemented via a data radio network, which connects the Control Points to the computer workstations, servers and packet switches located within the Centralized Equipment Maintenance and Operations Facility (CEMOF).

C. The three major parts of the ATCS Data Radio System are the Base Station radio sites, the Control Point radio sites and the CCF (Central Control Facility) Head-end interface. The ATCS protocol is utilized for the data radio communication links between the Base Station sites and the network of Control Point radio sites,

as well on the DS0 communication links between the Base Station sites and the CCF.

D. Two (2) ATCS frequency pairs are utilized to implement the network paths and network redundancy. The two frequency pairs are: ATCS channel 2, which is used at the Monument Peak and San Bruno Mountain Base Station sites, with full coverage overlap and redundancy for Control Points from CP Mayfield as the south limit to CP 4th street as the north limit. ATCS channel 5, which is used at the Monument Peak and CEMOF Base Station sites, with full coverage overlap and redundancy for Control Points from CP Michael as the south limit and CP Mary as the north limit. CP Lick, receives coverage support only from the Monument Peak site, yet is a part of the ATCS network, because it is monitored, not controlled, by Caltrain.

E. ATCS communication Backhaul between base station sites and the "Office" is provisioned via a Caltrain-owned microwave radio network, with nodes at the Monument Peak ATCS base station site, San Bruno ATCS base station site, San Carlos Headquarters and CEMOF.

1.04 EXISTING SYSTEM DESCRIPTION - BASE STATION SITES

A. Caltrain railroad consists of approximately 78 miles of railroad tracks serving freight and passenger operations between San Francisco and Gilroy. A total of three Base Station sites are used to support all message transmissions between the CCF and these Control Points (CP). The three Base Station sites used are located at Monument Peak in Milpitas, San Bruno Mountain in Daly City and at the CEMOF in San Jose (all in California).

B. The three Base Stations (two on mountain tops and the single base station at CEMOF) are configured in pairs as redundant to each other, to the extent of their respective radio coverage footprints. The Monument Peak and San Bruno Mountain sites are each capable of providing ATCS data radio support to all of the North Dispatch Control Points along the Peninsula Corridor. Pairing the CEMOF site with the Monument Peak site provides full radio coverage and/or coverage redundancy for the South Dispatch Control Points from CP Michael at its south limit to CP Mayfield as its north limit.

Note, the design criteria for the addition of a Control Point to the ATCS Data Radio network is that it must receive full radio coverage, with an availability of at least 99 percent, from a minimum of two Base Station sites, otherwise it shall be supported using leased telephone circuits. CP Lick, which is the southernmost CP, is not "controlled" by Caltrain, but simply "monitored", hence this coverage criterion does not apply to it.

1.05 EXISTING SYSTEM DESCRIPTION - CONTROL POINTS

A. Currently approximately 31 Control Points (circa 2011) are in operation, between CP Fourth Street to the north and CP Lick to the south, of which 27 are on the ATCS data radio network.

B. For ease of maintenance, the antenna towers used at each Control Point are a tilt down design capable of safely lowering the antenna and cable without damage.

1.06 EXISTING SYSTEM DESCRIPTION - CCF HEAD-END

A. The management of the ATCS network is performed at the CCF Head-end. A Dispatch Console, a Code Server and a Packet Switch are configured to manage the network. At the CCF, the dispatcher implements a route request by first inputting a control command into the Code Server. The Code Server decodes the command and passes another encoded message to the Packet Switches, which have the dual function of ensuring that the output protocol to the Base Station network is implementing the ATCS protocol (gateway function) as well as decide which Base Station site will be the most-likely-server for the Control Point being commanded (router function). Caltrain uses a Code Server manufactured by DigiCon Incorporated. The DigiCon Code Server does not implement the ATCS protocol. Instead, a variety of other protocols are supported and implemented in the Caltrain system. This Digicon system, replaced beginning 2012, by a new IP based dispatch console head-end provided by AIRINC, called AIM dispatch head-end console.

B. The Supervisory Control Systems (SCS)-128 protocol, developed by Safetran Systems (Invensys), is used for all direct, leased telephone line links between Control Points and the CCF, as well as for the links between the Base Station sites and the CCF.

C. The Genisys Protocol is also utilized. This protocol is used only for the direct, leased telephone line link between the major Control Point at Fourth Street and the CCF, and the leased line to CP Army. As Caltrain expands its data radio network, the use of the Genisys protocol, for the 4th Street site will be replaced with SCS-128. The Genisys at CP Army will be converted to ATCS. Further, in order to improve data radio throughput, the use of an ATCS protocol directly on the Digicon Code Server or AIRINC Front End Processor (FEP) shall be investigated. The Digicon Code Server is a rack-mounted computer, using a proprietary operating system developed by Digital Concepts Incorporated. It has the capability to support interfaces to several dispatch stations.

D. The CCF Packet Switches used in support of the ATCS data radio network are manufactured by Safetran Systems. They incorporate built-in hardware redundancy via the use of a dual packet-switch design in one box, one of which is redundant, and connected to the code server/FEP.

E. The Packet Switches shall convert all messages from the code server in SCS-128 protocol to the ATCS protocol. Likewise DS0 messages from the field Base Station sites, which are encoded with the ATCS protocol, shall be converted to SCS- 128 before being routed to the Code Server.

F. The CCF Packet switches shall also monitor the inbound signal quality (RSSI) from each of the 28 Control Points to their respective Base Station sites, in order to determine which Base Station site received the strongest signal from the Control Point. This RSSI information shall be used by the Packet Switch(es) to determine, in real time, which Base Station site will be the most-likely server, and shall route the next message from the Code Server to this Base Station site. Note: the current RSSI result is not saved for general future routing of messages to Base Station sites, but is used in real time for routing only the next outbound message to the most-likely-server Base Station site.

1.07 FUNCTIONAL REQUIREMENTS - COMMUNICATION LINKS

A. Caltrain owns and operates licenses for two ATCS channels. The two ATCS Data Radio Channels shall be configured to provide full duplex Data Radio Operation between the CCF and all Control Points along the Corridor. From the CCF, the Data Radio messages shall be transmitted to each of the Base Station sites via the use of Microwave Radio links (with a reliability of 99.999 percent or better) or direct 4-wire 600 ohm cable (in the case of the CEMOF base station) or the use of carrier-leased 4-Wire telephone circuits as a backup.

B. The Data Radios shall utilize the specification compliant ATCS communication protocol for communication between the Control Points and the Base Station Sites. The network can support the following interface options: HDLC LAPD, HDLC LAPB and/or TCP/IP. From the Base Station sites, the messages shall be transmitted to the Control Points along the Corridor via a pair of Multiple Addressing Scheme (MAS) ATCS frequencies licensed from the FCC, with a communications reliability of 99.0 percent or better, sufficient to ensure communications at 10 E-7 BER without FEC coding. A fade margin of 17dB shall be factored into the design to account for Rayleigh fading that will affect radio paths. The Base Station sites shall receive from 100 percent of the Control Points, likewise, with 99.0 percent communication reliability, providing 10 E-7 BER without FEC Coding.

C. The Communications back-haul serves to connect the CTC network and code servers, located at the CCF in the CEMOF in San Jose with the two mountain top ATCS Radio Base Station sites. Control requests and Signal indications are communicated between the CCF and the ATCS Radio Base Stations using this communications back-haul.

The existing voice radio communication backhaul uses a Caltrain-owned Microwave Radio network between the CCF and the following two ATCS Radio Base Station sites: Monument Peak and San Bruno Mountain. The communication backhaul between the ATCS Radio Base Station site co-located at the CEMOF facility is provisioned via a twisted-pair 4-wire circuit, less than 100 feet in length.

At the Monument Peak and San Bruno Mountain sites, the Caltrain has provisioned the infrastructure to support a two-wire data line backup, which is currently configured for cold-stand-by operation. Refer to Caltrain Design Criteria, Chapter 6, Train Control Communication for further details of the existing ATCS Radio communications back-haul.

1.08 FUNCTIONAL REQUIREMENTS - COMMUNICATION PROTOCOLS

A. The ATCS communications between the CCF (Code Server) and the Base Station sites shall be based on a polling scheme. Each Base Station site shall be assigned to a unique "code-line" on the Code Server, which shall poll each Base Station site in turn, in order to retrieve messages sent from the various Control Points.

B. The ATCS communication between the Base Station sites and the Control Points shall be based on a contention scheme. A pair of 900 MHz band ATCS

frequencies configured for a Multiple-Address-Scheme is used to implement the channel.

1.09 FUNCTIONAL REQUIREMENTS - FREQUENCIES AND LICENSING

A. The following ATCS channels and frequencies are used currently, and additional ATCS pairs shall be licensed as required:

ATCS CHANNEL	FREQUENCY	DESCRIPTION
2	935.9375 MHz	Base Station Tx. Frequency
2	896.9375 MHz	Base Station Rx. Frequency

ATCS CHANNEL	FREQUENCY	DESCRIPTION
5	936.9375 MHz	Base Station Tx. Frequency
5	897.9375 MHz	Base Station Rx. Frequency

B. Under this scheme, each Control Point, which has a message to send to the CCF, will "contend" for the radio channel with all other Control Points. This will result in some RF-Network collisions, the amount of which shall be kept to a minimum in order to preserve the designed maximum speeds and minimum head-ways.

C. Data Radio Base Station repeaters shall employ GMSK direct FM configured for 12.5 KHz channel spacing. Base Station antennas shall be directional, high gain antennas with the horizontal and vertical beam widths and orientation that would allow them to establish point to point radio links with each of the Control Points with the required communication reliability and signal quality. The Antennas used at Control Points shall be omni-directional or similar, which allows for efficient expansion of the ATCS network. In special cases, a high-gain directional antenna may be required to maintain system design specifications at certain Control Point location(s).

D. The quantity of collisions is a direct function of the ratio of Control Points to Base Stations: the higher this ratio, the greater the number of collisions; the larger the number of collisions, the lower the data throughput of the ATCS network. Additionally the reliability of the RF links is another factor that aggravates data throughput. As communication reliability falls below 99 percent, the number of communication re-tries increases, resulting in a longer time required to send or receive a message.

E. The third factor affecting data throughput is the protocol conversion overhead. Currently there are four (4) protocol conversions required per message round-trip (two per direction).

F. The maximum railroad speeds and the minimum railroad head-ways are dependent on these design parameters. As the system expands, a thorough analysis of these parameters will be necessary to ensure reliable and efficient operations.

1.10 DESIGN REQUIREMENTS

A. Design extension, upgrade or retrofit of the ATCS Data Radio Network, as applicable. Design shall be in accordance with applicable FCC rules and regulations.

B. Design Prerequisites: Execute and submit design of the Radio System in four iterative parts: the 30 percent, 65 percent, 100 percent, and IFB/IFC.

C. SCADA Interfaces: Equip mountain top Base Station Radio sites with Alarm monitoring and remote control/command interfaces that shall permit the Dispatcher at the CCF to monitor Alarm conditions at each site, as well as remotely reboot any component of the Base Station that is micro-processor based. The Base Station shall be interfaced to a SCADA system provided by others. The SCADA system shall be capable of reporting to the existing Train Control server.

1. As a minimum, the following alarms shall be provisioned:

    a. Low/ Loss of RF Power

    b. High VSWR

    c. Loss of AC Power

    d. Loss of DC Power

    e. Rectifier failure

    f. High Temperature

    g. Door Open

    h. Flooding (indoor sensors)

2. Each alarm shall be activated via a dry contact relay pair, which shall be normally open.

D. Radio Coverage Simulations: Utilize computer simulations to predict the reliability of the various ATCS UHF radio links between the Base Station sites and Control Points. These computer simulations shall utilize terrain data with a resolution no worse than 30 meters. Use the NAD 83 or later geodetic datum. The radio communication links between all Base Stations and Control Points shall have a reliability of 99.0 percent or greater.

E. Intermodulation Studies: For all new installations with three or more transmit frequencies, or those with less than three transmit frequencies but more than two external adjacent frequencies (of power, measured internal to the new

system, within 10 dB of the power of the transmit frequencies) that cannot be removed with notch filters, construct and execute an intermodulation study. This study shall examine all receiver intermodulation products created from the mixing of these transmit frequencies.

F. Structural Design: Provide structural design for new lattice, monopole or tilt-down towers, tower foundations, and civil structures associated with new installations required for the work of this Section. Design shall take into account specific soil types at each site. Drawings and calculations shall be signed and sealed by a professional engineer licensed in the State of California. Designs shall be based on the use of a geotechnical report prepared for the respective site(s) and shall include all calculations using maximum weights and wind loads supported by the towers.

1.11 SYSTEM AND EQUIPMENT UPGRADES

A. Caltrain is currently evaluating the following ATCS system and equipment upgrades:

1. ATCS to IP for all messages to/from Control Points resulting in an ATCS over IP message architecture.

2. A new IP based dispatch console/head-end to replace the obsolete Digicon Console and code servers. The AIRINC AIM dispatch head-end console and code servers will replace the existing Digicon Console and code servers in beginning 2012.

1.12 PTC RADIO SYSTEM

The positive train control system shall consist of the following components providing railroad safety and passenger services enhancements. The existing CTC system shall be loosely interfaced to the PTC radio systems and may share some site infrastructure/resources, such as Base Station sites.

1.13 SUBMITTALS

A. Design Submittals: Submit design documents in four phases in accordance with an approved submittal schedule. Obtain the Engineer's approval of each part before proceeding to more advanced parts.

1. 30 percent design document

2. 65 percent design document

3. 100 percent design document

4. Issued for Construction document

5. As Constructed (As-Built) document

The 65%, 100% IFB/IFC and As-Built design documents shall, at a minimum, include the following documents:

a. Radio Coverage Simulations

b. Intermodulation Studies

c. Grounding and Lightning Protection: In accordance with requirements indicated on the Contract Drawings, submit detailed drawings depicting the grounding configuration proposed for each radio site

d. Structural Design Calculations and Drawings

e. Radio "code plugs"

f Configuration management documents

B. Obtain Engineer's approval of any deviations from the specified design requirements. Submit request explaining the reasons for deviations and a description of the deviation itself for approval.

C. Product Data and Shop Drawings: Submit product data and manufacturer shop drawings at least 60 days prior to start of any installation.

1. Submit for approval catalog cut-sheets and other manufacturer literature and manufacturer shop drawings describing products proposed.

D. Installation Drawings: At least 60 days prior to the start of the installation of any item, submit a set of installation drawings for approval.

E. Test Plan And Procedures: At least ninety (90) days, prior to the start of testing, submit a test plan and test procedures to the Engineer for approval. The testing shall thereafter proceed only after written approval of the plan and procedures by the Engineer. All test plans and procedures involving the railroad ROW, or affecting an active signal or communication system shall follow the Site Specific Work Plan (SSWP) process.

F. Quality Assurance: Submit the resume of the Radio Communication Engineer for approval.

G. Operation and Maintenance Manuals, Training, And Spare Parts: Submit Operations and Maintenance (O&M) Manuals, a training plan, and a list of recommended Spare parts.

1. Submit O&M Manuals for all systems and devices provided under this Section. Operations and Maintenance Manual for the Radio System shall include electrical and mechanical specifications of all the components and sub-assemblies used to construct the system.

2. Training Plan: At least 60 days prior to training, submit Training Plan including Operation and Maintenance Manuals and a training outline for the approval. Submit resumes of the instructors.

3. Spare Parts List: Submit a list of recommended spare parts for approval at least 60 days prior to the start of training. Include manufacturers' prices.

H. Test Equipment and Special Tools: Submit list at least 30 days prior to start of training. Submit list of test equipment and special tools required for the optimal maintenance of the radio system provided. List shall be complete with cost quotations.

I. Cut-Over Plans: Submit cut-over plans for approval.

J. As Built drawings shall be submitted no later than 30 days after system acceptance. To ensure accuracy of the "As-Builts" , a set of "red-line" as-constructed drawings shall be maintained at each site for which construction and installation work are in progress.

1.14 QUALITY ASSURANCE

A. Qualifications: Only qualified Radio Communication Engineer(s) shall be allowed for the performance of this work. Radio Communication Engineer shall be a professional Electrical Engineer licensed in the State of California, and shall have designed or integrated at least two similar projects in the last five years.

B. The Contractor shall include a Software Configuration Management document with all design documents to ensure that Caltrain maintains an accurate and documented record of all versions of "code plugs" and software deployed to support the ATCS network.

1.15 MAINTENANCE MATERIALS

A. Spare Parts: Furnish spare parts for Caltrain's use in the following quantities. For the total quantity of each powered (active) device provided, furnish 20 percent (rounded to the next highest number) as spares. For the total quantity of each passive (un-powered) device provided, furnish 15 percent (rounded to the next highest number) as spares. These spare parts shall not be used by the Contractor in the correction of defective work under the Guaranty of Work.

PART 2 – PRODUCTS

2.01 GENERAL

A. Use the equipment identified herein in the design, extension, upgrade, or retrofit of the ATCS network.

2.02 BASE STATION EQUIPMENT

A. These following specifications for the ATCS Data Radio Base Station equipment are based on the SAFETRAN BCP ATCS data radio transceiver. The Contractor may submit alternate BCP transceivers, manufactured by others, to the Engineer for consideration.

TABLE 2.1 Base Station Data Radio Technical Specifications

GENERAL:	
FCC Compliance	Parts 15, 90
Transmitter	
RF Power Output	25-75W Adjustable
Spurious Emissions	-90 dBc
Harmonic Emissions	-90 dBc
Frequency Stability	‟0.1 ppm, -30°C to +60°C
	(-22°F to + 140°F)
RF Data Communication	
Frequency Range	Transmit: 935, 936 MHz
	Receive: 896, 897 MHz
Channel Spacing	25 kHz
Data Modulation	GMSK, Direct FM
RF Bit Rate	4800 bits/sec
Error Correction	Reed-Solomon (16,12) Forward
	Error Correction (FEC) and 16 bit
	Cyclical Redundancy Check (CRC)
	per ATCS Spec. 200 Appendix L
Ground Network Port	
Port Type	Sync. / Async., EIA-232 with Configurable Ports
	Modem Signaling
Baud Rate	Up to 2.048 Mbit/sec 9600 bit/sec typical
Data Link Protocol	HDLC Balanced
	per ATCS Spec. 200, Appendix K;
	HDLC Polled
	per ATCS Spec. 200, Appendix J
Receiver	
Sensitivity 12 dB EIA SINAD	0.35 uV
20 dB Quieting	0.50 uV
Adjacent Channel Rejection	-75 dB
Spurious and Image Rejection	-90 dB

Hum & Noise Ratio	-45 dB
Frequency Spread	5 MHz
Frequency Stability	+0.1 ppm, -30°C to + 60°C
	(-22°F to + 140°F)
Diagnostic Service Port	
Port Type	Async. EIA-232
Baud Rate	19200 bit/sec typical
Data Link Protocol	ANSI, 8 Data bits
	No Parity, 1 Stop bit
Electrical Requirements	
AC Input Voltage	120-240 VAC @ 50-60 Hz
AC Input Current	0.4A (Standby @ 117VAC)
	1.8A (Tx@ 25W, @ 117VAC)
	3.3A (Tx @ 75W, @ 117VAC)
AC Input Power	47W (Standby)
	211W (Tx@25W)
	390W (Tx@75W)
DC Input Voltage	26.5 VDC
DC Input Current	6A (Tx@25W)
	11A (Tx@75W)

TABLE 2.2 BASE STATION UHF Antenna Specifications

Frequency	890-940 Mhz
Pointing Azimuth	Base Station: Directional Control Points: Omni-directional or similar
Bandwidth for 1.5 to 1 VSWR	50 Mhz
Horizontal Beam width (1/2 power points)	As required
Vertical Beam width (1/2 power points)	As required
Gain	As required
Antenna Impedance	50 ohms
Front to Back Ratio	20 dB or better

Lightning protection (through support pipe)	DC Ground

2.03 CONTROL POINT EQUIPMENT

A. Furnish either 80, 60 or 40 foot, Tilt-Down Towers, as determined by the design, from Western Towers or approved equal. Height of the tower shall be as indicated in the Contract Documents or as proposed by the Contractor and approved by the Engineer. Foundations for 80 foot towers shall be pre-built by tower manufacturer. Furnish padlock of size and type approved by the Engineer. Padlock shall be four (4) inch or larger padlock as manufactured by Master Lock or equal. Include the following at each tower:

1. Aluminum mast in order to raise the overall height of the Tilt-Down tower plus mast to height indicated in the Contract Documents. (Note, Antenna plus Aluminum mast shall have a combined weight no greater than 20 pounds)

2. A 900 MHz lightning arrestor

B. Furnish the Mobile Communications Package (MCP) Radios from Safetran Systems (Invensys) or from GE/ Harmon or Engineer approved equal.

C. Provide the coaxial cable, CP Antennas, Ethernet Spread Spectrum radios (where required per the design), the 12Vdc batteries and chargers and other Data Radio products procured from the sources listed in Table 2.3 below or from an Engineer approved equal source.

D. Provide 7/8 inch coaxial cable transmission line complete with Type N connectors (Male to mate with N female on antenna and N Female for the other end of the 7/8" coaxial cable transmission line). Furnish a minimum of one spare connector of each type. Provide a minimum of two (2) weatherproofing/heat-shrinking kits.

TABLE 2.3 Data Radio System Product (Equipment List)

Item No.	Equipment Description	Equipment Part No.	Manufacturer/ Vendor
1	Spread Spectrum (Ethernet) radio	A53325	Safetran (Invensys)
2	WCP II ATCS Radio	9011-53411-0205	Safetran (Invensys)
3	Router	2811	Cisco Systems
4	Ethernet Switch	Part of Item No. 3	Cisco Systems
5	WAG	A53457	Safetran (Invensys)
6	UPS	APC	SUA1500RM2U
7	Batteries	SAFT	ED 240
8	Battery Charger	NRS	ERB-C 12/201 C, ERB-C 12/401 C
9	DC/DC Converter	Part of #2	Safetran
10	2.4 GHz Lightning Arrestor	IS-MT50LN-MA	Polyphaser/ Tessco

11	900MHz Lightning Arrestor	DSXL-D-ME	Polyphaser/ Tessco
12	PLC	N/A	Allen/Bradley
13	Spread Spectrum 2.4 GHz Antenna	WISP24009PTNF	Maxrad/Tessco
14	ATCS 900MHz Antenna	DB586-Y	Decibel Products /Tessco
15	Coaxial Cables	LCFS114-50A	Cellwave/Andrew
16	Coaxial Cables	LCF78-50A LCF12-50A	Cellwave/Andrew Cellwave/Andrew
17	Tilt-Down Antenna Mast & Installation accessories	N/A	Various
18	Miscellaneous Accessories	N/A	Various

TABLE 2.4 Control Point Data Radio Technical Specifications

General	
Dimensions	5 inches high by 10 inches wide by 10 inches long
Weight	16 lbs.
FCC Compliance	Parts 15, 90

Transmitter	
RF Power Output	30W Normal
Duty Cycle	Per TIA-603
Spurious Emissions	-65 dBc
Harmonic Emissions	-65 dBc
Frequency Stability	1.5 ppm, -30°C to 60°C
	(-22° to + 140°F)
RF Data Communications	
Frequency Range	Receive @ 935-941 MHz
	Transit @ 896-902 MHz, Normal
	Transmit @ 935-941 MHz, T/A Mode
Number of Channels	6 pairs (Synthesized, programmable)
Channel Spacing	12.5 kHz
Channel Resolution	12.5 kHz
Data Modulation	GMSK, Direct FM
RF Bite Rate	4800 bits/sec
Error Correction	Reed-Solomon (16, 12) Forward

Error Correction (Cont.)	Error Correction (FEC) and 16 bit
	Cyclical Redundancy Check (CRC)
	per ATCS Spec. 200. Appendix L
RF Channel Access	Data "Busy-Bit" protocol
	per ATCS Spec. 200, Appendix I
Client Ports	
Types of Ports	3 software configurable interfaces
	2 Sync. / Async., EIA-422/EIA-232
	1 Sync. / Async., EIA-422
Baud Rate	9600 bit/sec typical
Data Link Protocol	HDLC Balanced
	(Sync. Or PPP Async.)
	Per ATCS Spec. 200, Appendix K
	HDLC Polled (Dial Backup)
	Others Available
Alarm Inputs	7 Total

Receiver	
Sensitivity 12 dB EIA SINAD	0.35 uV
Selectivity	-70 dB
Intermodulation Rejection (EIA SINAD)	-65 dB
Spurious and Image Rejection	-75 dB
Frequency Stability	1.5 ppm, -30° to + 60°C
	(-22°F to + 140°F)
Input Impedance	50 ohms
Diagnostic Service Port	
Port Type	Async. EIA-RS-422
Baud Rate	19200 bit/sec typical
Data Link Protocol	HDLC
Electrical Requirements	
DC Input Voltage	13.6 VDC, Negative Ground
DC Input Current	3A (Rx)
	14A (Tx)

2.04 CCF HEAD-END EQUIPMENT

A. Due to the nature of the CCF Head-end interfaces, Caltrain will not allow equipment substitutions to the major CCF assemblies identified below, unless the Contractor can prove that the substitutions will not compromise the stability and reliability of the system. Generic network equipment such as switches and hubs can be replaced with COTS products.

TABLE 2.5 CCF Head-End Equipment

TABLE 2.5 CCF Head-End Equipment				
Item No.	**Equipment Description**	**Equipment Part No.**	**Manufacturer/ Vendor**	**Substitutions Allowed**
1	Code / FEP Server	Various	AIRINC AIM	Disallowed
2	Packet Switch	Various	Safetran (invensys)	Disallowed
3	Dispatch Workstation	Various	AIRINC AIM	Disallowed

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install system in accordance with the approved shop and construction drawings and manufacturers written procedures.

B. Installers shall provide environmental protection of all outdoor installations: connectors shall have protective sleeves for weatherproofing, cabling and equipment shall be secured against strong winds, and electronics shall be mounted in NEMA 4 enclosures. Where antennas or other equipment is mounted on towers or poles, installations designs shall be stamped by a registered Civil Engineer, licensed in the State of California to ensure equipment does not exceed the maximum load of the tower or pole.

3.02 TILT-DOWN TOWER INSTALLATION

A. Install tilt down towers as the Antenna Tower at each CP in accordance with approved installation drawings, manufacturer's instructions and design submittals. Follow the manufacturer's written safety precautions for the installation and lowering of the tower. In particular, ensure that the path of the rotating tower arm is parallel to the track(s) as it spins about the pivot and is clear of overhead power lines and other obstacles. The Tilt-Down tower shall not be within 10 feet of the nearest rail, or any point above the tracks at any point during its range of motion or while in the full horizontal position.

B. Install foundations for 80 foot Tilt-Down towers per detailed instructions provided by the manufacturer. Install cast-in-place concrete foundations in accordance with approved submittals for 40 and 60 foot towers.

C. Ground the entire Tilt-Down tower and foundation assembly in accordance with the approved submittals.

D. Lock the pivot of the tilt down tower immediately after the erection of the tower with padlock. The Tilt-Down tower shall remain locked, until such time as the Owner takes possession of it and replaces this lock.

E. In the process of installing tower foundation and grounding system, cad-weld the ground wires to the steel foundation.

F. Utilize a trained installation technician to prepare and install coaxial cable transmission line connectors.

G. Ensure there is the correct Data cable to interface the VHLC to the data port of the MCP radio, and also the correct code plug.

3.03 TESTING

A. Thoroughly test all installations and thoroughly document tests. Test radio system to ensure that the minimum RF coverage requirements specified herein are met.

B. Test Plan:

1. Prepare a plan which shall, at a minimum, define the types of test to be performed, the sequence of these tests, as well as any conditions that would require any changes to the amount, type or sequence of said tests. In addition, identify the personnel and protocol responsible for the execution, witnessing, and acceptance of these tests. Include a sample of test data sheets.

2. At a minimum, include in the test plan and develop detail test procedures for the following categories of tests:

a. Factory Acceptance Tests (FAT)

b. Site Acceptance Test (SAT)

c. Miscellaneous Field Tests

d. Radio Coverage Tests

e. System-wide Field Acceptance Tests (SWFAT)

C. Perform all required Factory Acceptance Tests (FAT), Field Tests, (which may include ground resistance tests, battery capacity tests and site alarm tests), Radio Coverage tests and System-wide Field Acceptance Tests (SWFAT), in accordance with the approved Test Plan.

D. Perform Factory Acceptance Tests for all components, subsystems or subassemblies that are manufactured independent of other subsystems or subassemblies. Notify the Engineer when Factory Acceptance Tests are performed sufficiently in advance of tests to give the Engineer the opportunity to witness tests. The Engineer may, at his sole discretion, elect to waive some of these FATs.

E. Perform miscellaneous field tests on any component, subsystem or subassembly that is required to be put into service prior to the completion of the SWFAT. These may include ground resistance tests, battery capacity tests and site alarm tests.

1. Prior to cutting the system over, conduct a Voltage Standing Wave Ratio (VSWR) sweep and an impedance test on the end-to-end connection of the three sections of coaxial antenna cable (less the lightning arrester) at new tilt-down tower installations.

F. Perform radio Link testing between all Base Station sites and the Control Points they serve. Individually test all links for the downlink as well as the uplink paths. Attach a computing device, configured to measure BER, at the end of each link under test in order to verify that they meet the minimum data error requirements.

G. Conduct Systemwide Field Acceptance Testing (SWFAT) in all areas where the radio coverage or radio equipment interfaces to users or other subsystems. Conduct these tests only after the radio system is placed in its final configuration and interfaced to all other systems with which it is expected to interact during normal operations. The tests shall fully demonstrate the operation of all the radio sites, Base Stations, and equipment as a single system, capable of meeting all of the coverage, reliability and other specification parameters defined herein.

3.04 CUT-OVER

A. Prepare a cut-over plan, where applicable. Plan shall clearly and thoroughly define the required sequence of activities, including staging, installation and testing of all materials and subsystems, in such a way as to minimize interruption to the Caltrain's revenue system and other railroad operations.

B. Execute approved cut-over plan.

3.05 TRAINING

A. Provide a training program for Caltrain and their Operating Railroad of Record personnel at least four 4 , but no earlier than 13 weeks, prior to the completion of the final acceptance testing. Training shall be tailored for maintenance and Operations personnel, and training material specific to these two groups shall be designed and provided. Duration of training as well as the class size shall be as specified in the Contract Documents.

B. The following are the minimum required items in the course outline:

1. Prerequisite Mathematics

2. Prerequisite Background/Introductory material

3. Detailed System Description

4. System Tolerances

5. System Troubleshooting

6. As-Built Drawings of Radio System

END OF SECTION

SECTION 20110

BALLAST AND WALKWAY AGGREGATE

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes specifications for furnishing and placing ballast and walkway aggregate. For the purpose of this Section ballast refers to ballast for main tracks and walkway aggregate for maintenance of way walkway. Obtain ballast only from the sources or quarries already approved by Owner.

1.02 REFERENCE STANDARDS

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

1. Manual of Railway Engineering Chapter 1, Roadway and Ballast

B. ASTM International (ASTM):

1. C29 Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate

2. C88 Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

3. C117 Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing

4. C127 Standard Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate

5. C131 Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

6. C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

7. C142 Standard Test Method for Clay Lumps and Friable Particles in Aggregates

8. C535 Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

9. C702 Standard Practice for Reducing Samples of Aggregate to Testing Size

10. D75 Standard Practice for Sampling Aggregates

11. D3744 Standard Test Method for Aggregate Durability Index

12. D4791 Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

13. E11 Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

C. California Public Utilities Commission (CPUC) General Orders (G.O.):

1. 118 Construction, reconstruction and maintenance of walkways and control, of vegetation adjacent to railroad tracks

1.03 SUBMITTALS

A. Submit Certificates of Compliance for ballast and walkway aggregate certifying that the materials meet the requirements specified herein including laboratory test results accompanied by a written report from the testing lab. The testing shall not be older than 90 days and performed on samples taken from production stockpile.

B. Submit at least one 150-lb. ballast test sample.

C. Submit name and location of ballast source, production rates, and production logistics.

D. Submit detailed plans and descriptions for shipping, handling, and placing ballast.

1.04 DELIVERABLES

A. Submit a report confirming the readiness of the subgrade for ballast placement including as-built subgrade elevations and compaction test results. Subgrade elevations and cross slopes shall be recorded every 10 lineal feet.

B. Laboratory test results for all tests used in determining minimum property and gradation requirements of ballast.

1.05 QUALITY ASSURANCE

A. Refer to Section 01400, Quality Control and Assurance. Ballast is subject to inspection and testing by the Engineer at any time between quarry production and acceptance of track.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Load ballast at the quarry, transport, and unload directly on the track. Engineer may allow transportation by truck if the Contractor can ensure that the segregation, degradation, or contamination of the ballast would not occur as a result of trucking and placing.

PART 2 – PRODUCTS

2.01 MATERIAL PROPERTY REQUIREMENTS OF BALLAST/WALKWAY AGGREGATE

A. Ballast/walkway aggregate production and handling facilities shall conform to the AREMA Manual, Chapter 1, Section 2.5, Production and Handling.

B. Ballast/walkway aggregate shall be crushed stone broken by the crusher and have at least 2 broken surfaces: angular, rough-surfaced, clean and free of sand, loam, clay, flat, elongated, soft or disintegrated pieces, and other deleterious substances.

1. The Ballast/walkway aggregate shall conform to the property requirements shown in the following table.

MINIMUM PROPERTY REQUIREMENTS
BALLAST/WALKWAY AGGREGATE

Property	Minimum	Maximum	Test Method
Bulk specific gravity - Rock	2.70	--	ASTM C127
Degradation	--	20 %	ASTM C535/C131
Durability Test – Procedure A	65	--	ASTM D3744
Percent material passing No. 200 Sieve	--	1.0 %	ASTM C117
Absorption – Rock	--	1.0 %	ASTM C127
Clay lumps and friable particles	--	0.5 %	ASTM C142
Soundness - (Sodium Sulfate), 5 cycles	--	5 %	ASTM C88
Flat and/or elongated particles	--	5 %	ASTM D4791

C. Unacceptable ballast/walkway aggregate materials: Round rocks, boulders, cobbles or gravels.

D. Unacceptable ballast/walkway aggregate parent materials: Carbonates, sedimentary rock, alluvium, sandstone, limestone, and slag.

E. Obtain ballast/walkway aggregate material from one quarry source throughout the duration of the Contract.

2.02 GRADATION REQUIREMENTS OF BALLAST

A. Ballast (Modified AREMA Size No. 4A) shall fall within the following gradation requirements:

Nominal Sieve Size (Square Opening)	% Passing by Weight
2-1/2 inch	100
2 inch	90-100
1-1/2 inch	60-90
1 inch	10-35
3/4 inch	0-10
3/8 inch	0-3
No. 4	0-1.5

Ballast shall have a maximum Fouling Index (FI) of 2. FI is defined as follows:

FI = P4 + P200, .where: P4 is the weight percentage passing the 4.75mm sieve (No. 4 sieve), and P200 is the weight percentage passing the 0.075mm sieve (No. 200 sieve)"

B. Walkway aggregate (AREMA Size No. 5) shall fall within the following gradation requirements:

Nominal Sieve Size (Square Opening)	% Passing by Weight
1-1/2 inch	100
1 inch	90-100
3/4 inch	40-75
1/2 inch	15-35
3/8 inch	0-15
No. 4	0-5

2.03 WASHING

A. Wash processed ballast and walkway aggregate to remove fine particle contamination immediately prior to loading at the quarry for delivery.

PART 3 – EXECUTION

3.01 EXAMINATION AND CORRECTION OF SUBGRADE

A. Prior to placing ballast on track subgrade, perform a final check of the condition of the track subgrade as to line, grade, cross section, and compaction.

1. Verify that track subgrade or subballast does not vary more than 1/2 inch from the design elevations and the line cross sections.

2. Repair uneven or settled subgrade with aggregate base or material approved by the Engineer in accordance with the requirements of Section 02310, Aggregate Base Courses, and Section 02300, Earthwork.

3. Compact subgrade in accordance with the requirements of Section 02310, Aggregate Base Courses, and Section 02300, Earthwork.

4. Prior to the placement of ballast, submit a report listed under Deliverables herein confirming the readiness of the subgrade.

B. Do not place ballast on soft, muddy areas. Repair the unsuitable area for approval by the Engineer.

3.02 GENERAL

A. At any time ballast is found to not conform to these specifications, stop ballast delivery and operations until ballast that does not conform to these specifications is removed and replaced.

B. Remove and replace ballast that becomes contaminated with fines or other deleterious material with new ballast.

3.03 BALLAST DISTRIBUTION

A. Obtain Engineer's approval of subgrade prior to distributing ballast.

B. Unload ballast directly from rail cars onto the track. Distribution by truck or loader is subject to the approval of the Engineer.

C. When distributing ballast, prevent forming of ruts that would impair proper drainage of the subgrade surface. Level and re-grade ruts to drain prior to placing ballast.

D. Unload ballast as close as possible to the point of use so to prevent unnecessary handling. Do not handle ballast more than two (2) times from the quarry to the track unless otherwise approved by the Engineer. Pick up excess ballast and ballast that is mixed with soil or fouled during distribution and replace with new ballast.

E. Place ballast to the lines and grades as shown on the Contract Drawings or referenced Caltrain Standard Drawings.

F. Salvaged excess or fouled ballast shall not be used as backfill, bedding or as fill materials unless otherwise approved by the Engineer.

3.04 WALKWAY AGGREGATE DISTRIBUTION

A. Distribute walkway aggregate and place in areas of walkways in track and special trackwork as required in Caltrain Standard Drawings, and in compliance with CPUC General Order 118 and in other areas as shown on the Contract Drawings and as described in Section 20500, Special Trackwork. Also place walkway aggregate around non-track underdrains and other areas as shown on the Contract Drawings.

B. Place walkway aggregate only after ballast on main track has been completely surfaced, tamped, and dressed. Do not mix walkway aggregate with ballast for purposes of tamping of track structure.

C. Place the walkway aggregate only after subgrade and backfill have been completely compacted and cleared of debris.

3.05 QUALITY CONTROL AND TESTING

A. Refer to Section 01400, Quality Control and Assurance. Testing shall be performed by an approved Inspection and Testing Agency retained by the Contractor.

B. Sample and test ballast material, during construction to ensure continued conformance with the requirements of this Section. The laboratory shall transmit test results directly to the Engineer with copies to the Contractor. Ballast supplier's own quality control testing, and the Inspection Testing Agency's

testing shall sample ballast material from the same stockpile and at the same time."

C. Perform gradation tests ASTM C136 and C117 at least once every 500 tons, and perform tests in Table 1 of this Section no less than every 5,000 tons. Take ballast samples at the quarry, in stockpiles, in track, and at the Engineer's discretion.

D. Ballast Samples:

1. Perform gradation tests plus all of the tests specified herein on at least five (5) separate ballast samples at the quarry for the first 1,000 tons produced.

2. Test all samples of ballast material for conformance with ASTM D75. Sample sizes shall be sufficient to provide the minimum sample sizes required by the designated test procedures. Reduce test samples from field samples in conformance with ASTM C702.

3. If the ballast consistently fails the gradation test for excess materials passing the No. 4 or No. 200 sieves, fully wash the ballast at the quarry. Consistent failure means three (3) or more failures per 500 tons sampled.

E. Gradation Test:

1. Perform sieve analysis conforming to ASTM C117 and ASTM C136. Sieves shall conform to ASTM E11.

F. Other Tests:

1. Determine bulk specific gravity and absorption in conformance with ASTM C127.

2. Determine percentage of clay lumps and friable particles in conformance with ASTM C142.

3. Perform resistance to degradation of materials test in conformance with ASTM C131 and ASTM C535. Materials with gradations with particles larger than one inch shall be tested in conformance with ASTM C535.

4. Perform soundness test in conformance with ASTM C88.

5. Perform durability test in conformance with ASTM D3744, Procedure A.

6. Determine unit weight in conformance with ASTM C29.

G. Materials Not Meeting Specified Requirements:

1. For #4 and #200 sieves only: In the event a rolling average of three tests fails to meet the gradation or material requirements specified herein, the Engineer may suspend placement of the ballast and require

immediate corrective action be taken to restore the specified gradation and material requirements, prior to resuming ballast placement.

2. For all other sieves: In the event any individual sample fails to meet the gradation or material requirements specified herein, the Engineer may suspend placement of the ballast and require immediate corrective action be taken to restore the specified gradation and material requirements, prior to resuming ballast placement.

3. Gradation Test Reports for ballasts shall be provided to the Engineer within 24 hours of testing. All other test results shall be provided within 48 hours of testing.

END OF SECTION

SECTION 20120

TRACK APPURTENANCES AND OTHER TRACK MATERIAL

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes specifications for other track materials (OTM) for concrete and timber ties. OTM includes rail fastening systems, screw spikes, track bolts, nuts, spring washers, tie plates, tie hole plugging material, rail anchors, standard toeless joint bars, compromise joint bars, and insulated joints.

1.02 GENERAL

A. Section 01005, Contractor's Personnel and Equipment: Includes general requirements and submittals regarding railroad construction equipment used for work of this Section, including adzing equipment.

1.03 REFERENCE STANDARDS

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

1. Manual for Railway Engineering

B. ASTM International (ASTM):

1. F436 Standard Specification for Hardened Steel Washers Inch and Metric Dimensions

2. F606 Standard Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets

3. F3125 Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

C. Caltrain Standard Drawings

1.04 DEFINITIONS

A. Tie Plate: Plate which has a rail seat, either flat or canted, double shoulder parallel to the rail it supports, and with holes for spikes or other fasteners. The bottom of the tie plate is usually flat, but may be ribbed or of other design.

B. Resilient Fastening System: Rail fastening system consisting of clips, insulators and pad or tie plate to fasten rail to ties.

C. Rail Anchor: Device which clamps to base of rail and bears against side of crosstie (timber tie) to restrain longitudinal movement of rail.

D. Standard Joint Bar: Device used to connect the abutting end of contiguous rails of the same cross section.

E. Compromise Joint Bar: Joint bar used to connect contiguous rails of different cross section.

F. Insulated Rail Joint: Pre-fabricated joint used to inhibit the flow of electric current between contiguous rails.

1.05 SUBMITTALS

A. Submit QA QC plans related to certification demonstrating that vendor has the processes, personnel, and systems to produce high quality OTM.

B. Submit plan showing details for installation of OTM. Include manufacturer's installation instructions, where applicable.

C. Submit data documenting vendor past performance within the past 10 years furnishing OTM to class 1 or commuter railroads.

D. Submit Certificates of Compliance for all OTM. Include material qualification test reports for materials, components, and assemblies.

E. Submit product data for screw spikes.

F. Submit samples of track materials, if requested by the Engineer

G. Submit loading, packaging, shipping, and handling methods for approval of all OTM.

1.06 QUALITY ASSURANCE

A. Vendor's QA QC program shall be in accordance with AAR M-1003 or Caltrain approved equivalent QC program and in compliance with AREMA Portfolio of Trackwork Plans.

B. Perform material qualification testing for all materials, components, and assemblies.

1.07 DELIVERY

A. Deliver screw spikes to the work site in Engineer approved containers (kegs).

1.08 EXTRA MATERIALS

A. Any excess materials that are property of the Owner shall be packaged as specified and hauled to stockpile area designated by the Engineer.

1. Place excess new spikes in containers.

2. Palletize and band excess tie plates.

3. Place the excess rail anchors in nylon sacks on pallets.

PART 2 – PRODUCTS

2.01 TIE PLATES

A. Tie plates shall conform to the requirements as indicated in Caltrain Standard Drawings.

B. Tie plates for use with elastic fasteners shall be standard 7-3/4 inches by 16 inches in accordance with Caltrain Standard Drawings.

2.02 TRACK SCREW SPIKES, TRACK CUT SPIKES

A. Screw spikes shall be new 15/16 inch by 6 or 6.5 inches straight shank screw spikes with a minimum tensile strength of 74,000 psi and a minimum yield strength of 37,000 psi. Head shall be hot forged and centered relative to the shank in accordance with Caltrain Standard Drawings.

B. Stamp screw spikes with manufacturer's identification and date of manufacture (month and year).

C. Track Screw Spikes shall conform to the AREMA Manual, Chapter 5, Part 10, Section 10.1, Specifications for Steel Screw Spikes.

D. Track Cut Spikes shall conform to the AREMA Manual, Chapter 5, Part 2.

2.03 RAIL ANCHORS

A. Rail anchors shall be Heavy Duty, High Carbon Steel, Channeloc-type rail anchors or equivalent manufactured by Chemtron True Temper or Engineer approved equal.

B. Rail anchors shall be sized to conform to the rail section used.

C. Rail anchors shall conform to the AREMA Manual, Chapter 5, Part 7, Section 7.1, "Specifications for Rail Anchors."

2.04 TRACK BOLTS, NUTS AND SPRING WASHERS

A. Track bolts and nuts shall conform to the dimensions specified in the AREMA Manual, Chapter 4, Part 3, Section 3.3, Rail Drillings, Bar Punching, and Bolts

B. Track bolts and nuts shall conform to the requirements of the AREMA Manual, Chapter 4, Part 3, Section 3.5, Specifications for Heat-Treated Carbon-Steel Track Bolts and Carbon-Steel Nuts.

C. Spring Washers shall conform to the requirements of the AREMA Manual, Chapter 4, Part 3, Section 3.6, Specifications for Spring Washers.

2.05 RESILIENT FASTENING SYSTEM

A. Galvanized Pandrol E-2055 clip type or equal elastic fastening systems for use on timber standard ties and switch ties.

B. Galvanized modified Pandrol E-2063 or E-2063B clips, painted yellow, for use on timber ties at joint locations.

C. Galvanized Pandrol fast clips 1601 or 1603 as required for use on concrete ties outside of joint area

D. Galvanized modified Pandrol fast clips J2 for use on concrete ties at joint locations

2.06 STANDARD AND COMPROMISE JOINT BARS

A. Standard 36-inch toeless joint bars shall be 6-hole bars, and shall be of the size, shape, and punch necessary to fit the rail sizes, conforming to the requirements in Caltrain Standard Drawings.

B. Compromise joint bars shall be of the size, shape, and punch necessary to fit the rail sizes and sections being joined in conformance with Caltrain Standard Drawings.

C. Compromise joint bars shall conform to the requirements of the AREMA Manual, Chapter 4, Part 3, Section 3.4, Specifications for Quenched Carbon-Steel Joint Bars, Microalloyed Joint Bars, and Forged Compromise Joint Bars.

D. Furnish only factory designed and produced (forged or cast) compromise joint bars for joining rails of different sizes or sections.

E. Permanent connections of different size rails on main tracks and sidings shall be by using forged taper rails, compromise joint bars may be used for temporary work not exceeding 60 days with the approval of the Engineer.

2.07 INSULATED RAIL JOINTS

A. Furnish prefabricated insulated rail joints of the epoxy-bonded type as manufactured by LB Foster Rail Technologies or Engineer approved equal, in accordance with the following:

1. Joint Components: Furnish insulated joints complete with bars, end posts, bushing, washers, pin bolts, collars, washers and adhesives as recommended by the manufacturer for final installation.

2. Furnish new, smooth, straight bars providing full face contact, conforming to the applicable rail section, and fabricated from micro alloyed steel or quenched carbon-steel as specified in AREMA, Specification for Quenched Carbon Steel Joint Bars. The toe of the joint bar shall properly fit against the web of the rail. When elastically fastened, the joint bar shall provide adequate clearance to maintain electrical isolation.

3. Provide pin bolts of ASTM A325 structural steel furnished with the appropriate collar. Provide flat circular hardened steel washers in accordance with ASTM F436.

4. Bolt hole size shall be in accordance with the bonded insulated joint manufacturer's recommendation. If bolt hole diameter is larger than 1-3/16 inches, place ASTM A325 hardened washers between the joint bars and the nut.

B. Insulating paint for use in conjunction with insulated joints: As recommended by the insulated joint manufacturer and approved by the Engineer.

C. Each insulated joint shall be megohmmeter tested as per AREMA specifications.

2.08 TIE PLUGS

A. Tie hole plugging material shall be SpikeFast by Willamette Valley Company, or Engineer approved equal.

2.09 SUPERELEVATION TAGS

A. Furnish metal superelevation tags manufactured from 16-gauge aluminum in accordance with Caltrain Standard Drawings. Stamp tags in 1/4-inch increments from zero to maximum superelevation.

1. Nails for Securing Tags to Timber Crossties: Galvanized No 10.

2. Adhesive for Securing Tags to Concrete Ties must be approved by the Engineer.

2.10 BUMPING POST

A. Bumping Post shall be as manufactured by Western Cullen Hayes Model "WAC" Bumping Post, or equal. Cushion head shall be Western Cullen Hayes "Hayco Cushion Head" or equivalent that matches with the bumping Post. Bumping post shall be compatible for stopping Passenger Cars.

PART 3 - EXECUTION

3.01 TIE PLATES

A. Install tie plates in accordance with Section 20400, Track Construction and as specified in Caltrain Standard drawing SD-2221.

B. Adze existing ties to receive new ties plates, prior to installing new rail. Tie adzing shall only be of sufficient depth to allow for a full level seat for the new tie plate and remove indentation of old tie plate. The width of adze shall be the full width of the tie, and the length of the adze shall extend beyond the width of the tie plate seat by a minimum of one half inch of each side. Install the tie hole plugging material in all open spike holes prior to adzing.

C. Use only approved power operated adzing equipment for adzing, with an approved back-up adzer available on site at all times.

3.02 TRACK SPIKES

A. Track spikes and Track Screw Spikes shall be installed as specified in Caltrain Standard drawing SD-2221.

3.03 RAIL ANCHORS

A. Rail anchors shall be installed as specified in Caltrain Standard drawing SD-2215.

3.04 BOLTS, NUTS, AND SPRING WASHERS

A. The various rail drillings and joint bar punches require various lengths and diameters of bolt assemblies. Determine the number of bolt assemblies of each size requires. In general, all bolt diameters shall be the largest possible for a given rail drilling and joint bar punching. Bolts shall be the proper length for the joint bar to allow at least one full bolt thread to extend past the outside of the nut. Spring washers and nuts shall be of a size sufficient to ensure that the spring washer develops its full reactive force and does not jam into the joint bar hole.

B. Install bolt assemblies in accordance with the requirements of Section 20400, Track Construction.

3.05 RESILIENT FASTENERS

A. Install resilient fasteners in accordance with the requirements of Section 20400, Track Construction and Section 20500, Special Trackwork.

3.06 STANDARD AND COMPROMISE JOINT BARS

A. Install compromise joint bars in accordance with the requirements of Section 20400, Track Construction, and Caltrain Standard drawings SD-2231 for Joint bars, and SD-2233 for Compromise Joint bars.

B. Temporary bolted joints will be permitted for the Contractor's convenience to facilitate construction, unless otherwise directed by the Engineer. The use of bolted joints during the construction of CWR track shall be kept to a minimum, and all bolted joints shall be replaced by field welds prior to de-stressing.

3.07 INSULATED RAIL JOINTS

A. Install pre-fabricated insulated joints at locations shown on the Contract Drawings and in conformance with the manufacturer's recommended procedures. Install two insulated joints, on opposite rails at each callout on the Contract Drawing, with a stagger of 4'-8" minimum and 10' maximum. Polarity joints shall have a maximum stagger of 4'-6", see SD-5107.

B. Notify the Engineer 24 hours in advance of installation of insulated joints at each location.

C. Test all insulated joints after installation into track in accordance with the requirements in Section 18600, Signal Systems Testing.

1. Remove, replace, and retest any bonded insulated joint that fails the electrical test in track. Obtain Engineer's approval of insulated joint replacement procedure prior to making replacement.

D. Properly fasten the elastic fasteners to secure the insulated joints in place using Pandrol clips specified herein for resilient fastening at insulated joints. Use overdrive protectors when using E-2063B clips to obtain proper installation. Do not overdrive the clips.

E. Apply insulating paint to the circumference of the rail head and post after assembly and curing of bonded insulated joint adhesive. Apply the insulating paint as a stripe centered on the end post, one inch plus or minus 1/4 inch wide.

3.08 RAIL BONDS

A. Bond all jointed rail, both permanent and temporary, in accordance with the requirements in Section 18400, Rail Bonding.

3.09 TIE PLUGS

A. Plug all spike holes where spikes have been removed in existing ties that are to remain in track and that are to receive new tie plates or new spikes. Use tie hole plugging materials.

B. Install tie hole plugging material in accordance with the manufacturer's instructions. Top of tie hole plugging material shall be flush with top of hole.

3.10 SUPERELEVATION TAGS

A. Install tags in accordance with the Contract Documents and Caltrain Standard drawings. At concrete ties, follow adhesive manufacturer's instructions.

3.11 BUMPING POST

A. Bumping post shall be installed at three ties minimum from the end of track or per manufacturer's recommendation. No rail joint should be within the bumping post. Fully bolt the rail joints ahead of the bumping post. Use fully spiked sound ties ahead of and within the bumping post. Middle rail should be spiked for the entire length.

END OF SECTION

SECTION 20130

TIMBER CROSSTIES AND SWITCH TIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for timber crossties and switch ties in track construction, including special trackwork. Installation of timber ties is specified in Sections 20400, Track Construction, and 20500, Special Trackwork.

1.02 REFERENCE STANDARDS

A. Caltrain Standard Drawings

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

1. Manual for Railway Engineering

C. American Wood-Preservers' Association (AWPA):

1. P1 Standard for Creosote Preservative

2. P3 Standard for Creosote-Petroleum Solution

1.03 SUBMITTALS

A. Certificates of Compliance for preservative treatment, ascertaining conformance with the approved preservative within one week of completion of testing.

B. Inspection Certificate from the NHLA for grading compliance prior to application of preservative treatment.

C. Certificate of Compliance from manufacturer or suppliers certifying that the materials delivered to the site are in compliance with the requirements of this Section. Include supporting test results.

1.04 STORAGE AND HANDLING

A. Handle ties carefully to avoid damage in accordance with the AREMA Manual, Chapter 30, Part 3, Section 3.5, The Handling of Ties from the Tree Into the Track.

B. Stockpile new ties only where directed by the Engineer. Band ties with minimum of two bands in 12-tie bundle, and stack to a maximum of 3 bundles high, with slating between layers of bundles, and at a maximum height of 12 feet.

C. Choose storage locations with proper security, access, and drainage. Stack ties tightly and off the ground for storage to prevent them from becoming warped or damaged.

1.05 QUALITY ASSURANCE

A. Tie manufacturer Quality Control Program shall be in accordance with AAR M-1003 or Caltrain approved Quality Control Program.

B. Manufacturer's testing and inspection shall be performed by Vendor in conformance with AREMA, RTA, and AWPA Standards.

C. Caltrain shall have the right to access Manufacturer's plant during normal business hours to examine the process, method of treatment, and production records during any stage of tie production.

D. Materials not meeting the requirements of this section shall be sorted out at the manufacturer's facilities before shipping.

PART 2 - PRODUCTS

2.01 GENERAL

A. Ties shall be new oak or mixed hardwood with kerf mark to indicate heart wood side.

B. Timber crossties and switch ties shall have a cross-section of 7 by 9 inches, subject to the following:

1. Standard crossties shall be 7-inch, No 1 grade, 9 feet 0 inches long.

2. Transition/grade crossing crossties shall be 7-inch, No 1 grade, 10 feet 0 inches long.

3. Switch ties shall be full length, measuring full thickness and width throughout. Ties up to 1 inch wane or less will be inspected on an individual basis. Ties with more than 1 inch wane will be rejected. Ties with thickness and width more than 1/8 inch thinner or narrower than the specified size will be rejected.

4. Head block switch ties for manual throw turnouts shall be 8 by 12 inches.

5. Head block switch ties for power operated turnouts shall be 8 by 10 inches.

C. Do not use industrial grade crossties.

D. Any special timber ties for open-deck bridges shall be as specified and as shown in the Contract Documents.

2.02 TIMBER REQUIREMENTS AND BASIS OF REJECTION

A. General: Ties shall be fabricated from sound, straight, live timber, free from any defects that may impair their strength or durability, such as bark, splits, shakes, large or numerous holes or knots, pitch seams, pitch rings or other imperfections.

1. Ties with any type of decay or insect damage are not acceptable.

B. Except as specified in this Section, only those imperfections that are within the limits of the AREMA Manual will be allowed.

C. Rejection of ties for holes and knots: Ties with holes and knots (as defined below) between 20 and 40 inches from its middle will be rejected. Ties with these defects outside the rail bearing area may be rejected at the discretion of the Engineer.

1. Large hole: More than 1/2 inch in diameter and 3 inches in depth within, or more than 1/4 of the width of the surface on which it appears, and 3 inches deep outside, the sections of the tie between 20 inches and 40 inches from its middle.

2. Numerous holes: Any number of holes equaling a large hole in a damaging effect.

3. Large knot: One whose average diameter exceeds 1/4 the width of the surface on which it appears.

4. Numerous knots: Any number which, in total, equals a large knot in damaging effect.

D. Except in woods with interlocking grain, ties with a slant grain in excess of 1 in 15 will be rejected.

E. A check is a separation of the wood due to seasoning which appears on one surface only. Do not count the end as a surface. Ties with continuous checks whose depth in a fully seasoned or treated tie is greater than 1/4 the thickness and longer than 1/2 the length of the tie will be rejected.

2.03 TIE FABRICATION REQUIREMENTS

A. Ties shall be well sawed on all four sides and cut square at the end to the full dimensions specified. Straight and opposite faces shall be true and parallel.

B. Crossties and switch ties which comply with the following shall be considered straight:

1. Horizontally when it is concave or convex no more than 1 inch.

2. Vertically when it is concave or convex no more than 1/2 inch.

C. A tie will not be considered well sawn when its surfaces are cut into with scar marks more than 1/2 inch deep or when its surfaces are not even.

D. The top and bottom of a crosstie or switch tie shall be considered parallel if any difference in the thickness at the sides or ends does not exceed 1/2 inch.

2.04 END PLATES

A. All crossties and switch ties shall be end plated on both ends.

2.05 SEASONING

A. Crossties shall be seasoned in accordance with AREMA Manual, Chapter 30, Part 3, Section 3.5, The Handling of Ties from the Tree into the Track, and Section 3.6, Wood Preserving.

B. Pre-boring and dapping of crossties and switch ties shall be done prior to treatment to minimize splitting when driving spikes and provide preservative penetration around the spike holes. The boring pattern shall conform to the spiking pattern shown on the Caltrain Standard Drawings. Field boring of switch ties will be permitted if the hole is provided a method of preservative treatment approved in advance by the Engineer.

C. Bore from the top surface of the tie; bore shall not penetrate the bottom surface.

2.06 INCISING

A. Incise crossties and switch ties on all four sides in the pattern specified in the AREMA Manual, Chapter 30, Part 3, Section 3.7, Specifications for Treatment.

2.07 PRESERVATIVE

A. Preservative shall be in accordance with AWPA P3. Petroleum for blending with creosote shall comply with the AWPA P4.

B. Preservative applied to switch ties shall conform to AWPA P1.

C. Pressure treat ties in accordance with the empty cell process with a 50/50 to 40/60 creosote/petroleum base to a minimum retention of 7 pounds per cubic foot of wood, or to refusal retention.

D. Creosote-petroleum treatment solution shall be per AREMA Manual, Chapter 30, Part 3, Section 3.7.2, Treatment, and Section 3.7.4, Preservatives.

E. Apply the preservative only after the ties have a moisture content of 40 percent or less.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Prior to installation, perform a final visual inspection of the ties to ensure all ties to be installed are bored, branded, incised, and without defects.

3.02 INSTALLATION

A. Install ties in accordance with Sections 20400, Track Construction, 20500, Special Trackwork, and 20300, Timber Crosstie Replacement, as applicable.

END OF SECTION

SECTION 20140

CONCRETE CROSSTIES AND RAIL FASTENER ASSEMBLIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for furnishing and installing new prestressed, pretensioned monoblock concrete crossties and rail fastener assemblies for use with 136 RE rail.

B. The concrete crossties (standard crossties and grade crossing ties) shall be as shown on the Caltrain Standard Drawings, and as specified in this Section.

C. The concrete crossties shall be compatible to the specified rail fastener assemblies.

D. Crossties for grade crossings shall accommodate precast concrete crossing panels specified in Section 20600, Concrete Grade Crossings.

1.02 REFERENCE STANDARDS

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

1. Manual for Railway Engineering

B. ASTM International (ASTM):

1. A536 Standard Specification for Ductile Iron Castings

2. A881 Standard Specification for Steel Wire, Indented, Low-Relaxation for Prestressed Concrete

3. C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field

4. C33 Standard Specification for Concrete Aggregates

5. C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

6. C78 Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)

7. C109 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens)

8. C150 Standard Specification for Portland Cement

9. C172 Standard Practice for Sampling Freshly Mixed Concrete

10. C260 Standard Specification for Air-Entraining Admixtures for Concrete

11. C359 Standard Test Method for Early Stiffening of Hydraulic-Cement (Mortar Method)

12. C494 Standard Specification for Chemical Admixtures for Concrete

13. C864 Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers

14. D257 Standard Test Methods for DC Resistance or Conductance of Insulating Materials

15. D395 Standard Test Methods for Rubber Property-Compression Set

16. D412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension

17. D471 Standard Test Method for Rubber Property-Effect of Liquids

18. D570 Standard Test Method for Water Absorption of Plastics

19. D573 Standard Test Method for Rubber - Deterioration in an Air Oven

20. D648 Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position

21. D732 Standard Test Method for Shear Strength of Plastics by Punch Tool

22. D789 Standard Test Method for Determination of Relative Viscosity of Concentrated Polyamide (PA) Solutions

23. D1149 Standard Test Methods for Rubber Deterioration-Cracking in an Ozone Controlled Environment

24. D1229 Standard Test Method for Rubber Property - Compression Set at Low Temperatures

25. D2240 Standard Test Method for Rubber Property - Durometer Hardness

26. D4066 Standard Classification System for Nylon Injection and Extrusion Materials (PA)

C. American Concrete Institute (ACI):

1. PRC-211.1 Selecting Proportions for Normal-Density and High Density-Concrete - Guide

2. PRC-214 Guide to Evaluation of Strength Test Results of Concrete

3. SPEC-301-20 Specifications for Concrete Construction

D. Precast/Prestressed Concrete Institute (PCI):

1. MNL-116 Manual for Quality Control for Plants and Production of Structural Precast Concrete Products

1.03 SUBMITTALS

A. The following submittals to the Engineer are in addition to the requirements in Section 01300, Submittals and Deliverables.

B. Within 30 days of Notice to Proceed, prior to concrete crosstie and rail fastener assembly qualification testing:

1. Letter with supporting documentation stating that the crosstie manufacturer meets or exceeds the requirements per 1.5 of this Section.

2. Rail fastener manufacturer's approval of rail fastener application in the tie manufacture.

3. Shop drawings and associated design calculations for each type of crosstie including all information necessary for fabrication. Include plan, elevation and cross section with prestressing wires, rail fastener assemblies, and embedded items. Show dimensions, details, tolerances, finishes, concrete strength, and material specifications. Indicate part numbers.

4. Letter from the rail fastener assembly manufacturer stating that the concrete crosstie manufacturer’s shop drawings and processes are compatible with the rail fastener assemblies.

5. 3 samples each of the complete rail fastener assemblies, including embedded shoulders, rail clips, tie pads and insulators.

6. Qualification testing results including rail seat pad qualification testing, insulator qualification testing, and concrete tie and fastener assembly qualification testing.

C. Within 45 days of Notice to Proceed:

1. Concrete mix design with certified concrete and concrete components qualification test results.

2. Manufacturer’s Test Program Plan. The Plan shall, at a minimum, conform to the requirements of this Section and shall provide sufficient detail of the manufacturer’s quality assurance program.

D. Within 7 Days after Completion of Testing and Inspection:

1. Certified concrete tie and rail fastener assembly qualification test results prior to crosstie and rail fastener assembly production and after approval of the shop drawings.

2. Certified rail fastener assembly and concrete tie production test results, certified tie pad production test results, and certified material test reports prior to shipping the concrete ties and rail fastener assemblies.

E. At least 30 days prior to shipment, submit method of handling, loading, shipping, unloading and stacking concrete crossties, including working drawings showing the concrete crossties stacking arrangement.

1.04 DELIVERABLES

A. Certificate of Compliance one day after each shipment of concrete crossties. The Certificate shall state that the accompanying shipment of concrete ties fully complies with all the requirements specified in this Section.

B. Inventory records of concrete ties shipped at the time of each shipment.

C. Cement mill certificates.

D. Concrete tie and fastener assembly production quality control testing results.

1.05 MANUFACTURER QUALIFICATIONS

A. Concrete Tie Manufacture's Qualifications:

1. A minimum of 5 years' experience, in one location, of the large scale manufacture of pretensioned prestressed concrete crossties by the long line process with 5 to 8 lines per bed.

2. The plants shall be certified under the PCI Plant Certification Program.

3. Has supplied concrete crossties to a Class 1 Freight or Commuter Railroad within the last 5 years.

4. The Certificate of Qualification as the concrete crosstie supplier. Owner-approved manufacturers include CXT, Rocla, and KSA.

B. Rail Fastener Assembly Manufacture's Qualifications:

1. A minimum of five years' experience, in one location, of the large scale manufacture of rail fastener assembly for use in pretensioned prestressed concrete crossties.

2. Has supplied the rail fastener assemblies used on concrete crossties of a Class 1 Freight or Commuter Railroad within the last 5 years.

3. Owner-approved manufacturers include Pandrol.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Handle all ties such that to prevent damage (such as chipping, spalling, cracking, etc.) during loading, shipping, unloading and stockpiling. Do not drop, bang, scrape, or skid ties. Use only lifting devices appropriate for handling ties.

B. Securely brace ties for transportation to prevent any movement that could cause damage. Stack ties in upright position, separated uniformly with wooden spacer

blocks (align with the rail seat area) to clear fastener shoulder inserts. Do not load ties higher than 6 layers.

C. Package rail fastener assembly parts separately and in waterproof containers to prevent damage during shipment and to facilitate handling.

D. Store ties to prevent unnecessary additional handling until the final distribution. Store ties in separate stacks seggregated according to type of tie. Provide the necessary supports and spacers so that the ties will not contact the ground.

E. Replace concrete ties and rail fastener assemblies damaged during loading, shipping, unloading, and storage.

1.07 WARRANTY

A. Guarantee all items against defective materials, construction, or workmanship for a period of five (5) years from the date of the ties and associated fastener assemblies have been installed on the ground and accepted, except when a longer guarantee is provided by the supplier or manufacturer.

1.08 SPARE PARTS

A. Furnish and deliver as Owner spares each of the following, separately packaged and clearly marked "SPARE PARTS"

1. For every 5000 cross ties:

   a. 100 fast clips (galvanized) including insulators

   b. 50 sidepost insulators

   c. 50 tie pads

2. For each grade crossing:

   a. 10 e clips (galvanized)

PART 2 - PRODUCTS

2.01 CONCRETE CROSSTIE DESIGN CRITERIA

A. Concrete crossties shall meet the requirements in AREMA Chapter 30, Part 4 Concrete Tie. Flexural strength of tie shall be designed for 110 MPH speed and 15 annual MGT.

B. Fabrication Dimensions and Tolerances:

1. Track Gage: The concrete tie and fasteners shall hold track gage to plus or minus 1/16 inch. The centerline of the tie shall be within 1/2 inch of the centerline of the track gage.

2. Differential Tilt of Rail Seats: The differential tilt in the direction parallel to the rail of one rail seat to the other rail seat shall not exceed 1/16 inch over the width of the tie.

3. Concrete Cover for Prestressing wires: 3/4 inch minimum cover

4. Prestressing wires shall be 5.32 mm minimum diameter, conforming to ASTM A881, Grade 260

5. Surface Finish: Heavy concentrations of surface voids or evidence of improper mixing, vibrating, or curing are not acceptable.

2.02 CONCRETE DESIGN CRITERIA

A. Concrete Mix Design, in accordance with ACI

1. Qualify concrete mix design based on tests on trial batches, which shall show that concrete mix achieves the specified strengths and properties, including shrinkage and permeability.

2. Submit a new mix design to qualify the mix if any constituents of the concrete are changed during cross tie production.

B. Cement: ASTM C150 Type III low alkali (less than 0.60 percent alkali content)

C. Flexural Strength, tested in accordance with ASTM C78

1. Minimum 28-Day Flexural Strength: 750 psi

2. Obtain 6 inch by 6 inch by 20 inch test beams in accordance with ASTM C31. Cure test beams under production conditions.

3. Test one beam for every 2,000 ties for the first 6,000 ties produced

2.03 RAIL FASTENER ASSEMBLY DESIGN CRITERIA

A. General:

1. The fasteners shall be of threadless design. To ensure compatibility among all components of the rail fastener assemblies and compatibility to the ties, they shall be manufactured by a single manufacturer.

2. Note that the specified Pandrol fasteners and corresponding part numbers comply with the requirements in this Section. The specified part number may be different due to subsequent production change by Pandrol. The fasteners proposed for replacement shall meet or exceed the specified fasteners, and shall be as recommended, in writing, by the Pandrol, and submitted for the Engineer's approval.

B. Rail Tie Pads (tie pads): Tie pads shall be Pandrol 7083WB, 6.5 mm thick, Poly complying with the following requirements:

1. Minimize abrasion of the rail seat area, reduce impacts and vibration effects on the track structure and provide electrical insulation of the rail.

2. Provide a positive means of preventing movement of the pad parallel to the rail. The pad thickness shall be 6.5mm, a width to extend around the shoulder to lock it in place.

3. Manufactured from natural rubber or thermoplastics which provide the required chemical and physical properties to resist effects of temperature ranging from minus 20 degrees F to plus 160 degrees F, as well as oxidation, water, alkali, salt, petroleum products, synthetic lubricants, and sunlight. Manufacture pads of first quality, new ingredients, processed and cured in accordance with accepted standard industry practice. Oil-extended rubber, reclaimed rubber, or rubber containing wax is not acceptable.

C. Rail Clips: The clips shall be Pandrol Fastclip 1601 (for standard crossties), galvanized and Pandrol E-clip 2055 (for grade crossing ties), galvanized complying for requirements for ease of installation and maintenance. The clips shall be adaptable to track laying machine. They shall be one-piece elastic, heat treated, alloy spring steel forced and quenched to achieve the holding power. Spring-wedged clips are not acceptable.

D. Insulators: Insulators shall be Pandrol 7695 (toe insulators) and 7692 (post insulators), covering the full widths of the shoulders, complying with the following requirements:

1. Provide electrical isolation, reduce abrasion, and transfer dynamic loading from rail to rail clip to prevent relative motion in any direction.

2. Two (2) insulators for each rail fastener assembly, one on each side of each rail. They shall insulate the rail clip from direct contact with the rail, and also insulate the rail from the shoulder inserts.

3. Except for surfaces in contact with the rail, the surfaces of the insulators shall be smooth, clearly finished and free of flash. Insulators shall be free of internal defects and cavities.

4. Keys shall be provided between the insulators and the fastener hardware to prevent relative motion in any direction.

5. Shall be made of materials which provide the required electrical, chemical and physical properties to resist dynamic loading, oxidation, water, alkali, salt, petroleum products, synthetic lubricants, and sunlight through a temperature range of minus 20 degrees F and plus 160 degrees F. Recycled material is not acceptable.

6. Insulator material shall be injection molded nylon conforming to ASTM D4066, Group 1, Class 2, Grade 4, ultra-violet stabilized through the heat stabilizer.

7. Insulators shall be protected against oxidative embrittlement by inclusion of a non-conductive ultraviolet stabilizer which will not diminish the electrical insulation properties of the insulators.

E. Embedded Shoulders: Embedded shoulders shall be twin-stem Pandrol 9086, not directly anchored to the pretensioned wires, complying with the following requirements:

1. Provide and maintain proper position and alignment of the rail, rail clip, insulators, tie pad and running rail base. The shoulders shall be of ragged stem design to maximize the surface area and pull out resistance.

2. Made of ductile cast iron conforming to ASTM A536 Grades 60-40-18, or 65-45-12.

2.04 PRODUCTION

A. Prestressing Wires

1. Placement and Spacing: Place and space prestressing wires in accordance with the AREMA Manual, Chapter 30, Concrete Ties, Section 4.3 - Tie Dimensions, Configuration and Weight.

2. Supports: Accurately place and support prestressing wires before concrete is placed. Secure the prestressing wires against displacement greater than the permitted tolerances.

3. Prestressing wires: Inspect for proper surface condition. Prestressing wires shall be free of release agents or other substances.

B. Concrete Curing: Cure in accordance with the AREMA Manual for Railway Engineering, Chapter 30, Concrete Ties, Section 4.2 - Material, Article 1.2.2.5 – Curing.

2.05 SOURCE QUALITY CONTROL - GENERAL

A. Perform the testing required in this Section for the concrete crossties. Submit test results to the Engineer for review and approval.

B. Previous qualification tests performed on nearly identical concrete crossties produced for a Class I Freight or Commuter Railroad within the last 5 years may be acceptable in lieu of performing the required qualification testing.

C. Do not proceed with the production of the concrete ties until the shop drawings, concrete mix design, and qualification test result submittals have been reviewed and approved by the Engineer.

2.06 SHOP INSPECTION BY THE ENGINEER

A. Provide the Engineer written notice for inspection at least 30 days in advance of the initial in-shop inspection and 10 days in advance for subsequent in-shop

inspections. Do not prepare materials for shipment before the Engineer has either inspected the materials or waived inspection.

B. After material has been delivered and unloaded, conduct an inspection and issue a report to the Engineer.

2.07 QUALIFICATION TESTING REQUIREMENTS

A. Prior to approval, concrete ties design shall be subjected to testing for compliance with AREMA Chapter 30, Section 4.9 Testing of Monoblock Ties. The tests specified herein shall be performed at testing facilities approved by the Engineer.

B. Concrete ties and rail fastening systems shall be subjected to the acceptance tests as specified in AREMA Chapter 30, Article 4.9.1. Failure of the concrete ties and rail fastenings to pass the prescribed tests will be cause for rejection. Existing concrete tie and fastening designs which have already passed tests equivalent to those specified herein may be accepted without additional testing as determined by the Engineer. For such acceptance to be given, certified laboratory test reports shall be submitted in sufficient detail as required by the Engineer in order to make the determination as to equivalency.

2.08 PRODUCTION QUALITY CONTROL TESTING REQUIREMENTS

A. Perform quality control tests during production to assure concrete ties produced are uniform and in high quality. Production quality control testing program shall be the requirements as specified in AREMA Chapter 30, Article 4.9.2.

PART 3 - EXECUTION

3.01 CONCRETE TIE INSTALLATION

A. Prior to commencement of the crosstie installation, perform a final visual inspection of each tie to ensure all ties and their fastener assemblies are free of defects or damage and equipped with rail fastening assembly.

B. Install concrete ties in accordance with Section 20400, Track Construction, and related provisions.

END OF SECTION

SECTION 20150

RAIL

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for Contractor-furnished 136 RE Continuously Welded Rail (CWR). Rail installation is specified in Section 20400, Track Construction.

1.02 REFERENCE STANDARDS

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

1. Manual for Railway Engineering

2. Portfolio of Trackwork Plans

B. American Association of Railroads (AAR):

1. M-1003 Section J - Quality Assurance

C. ASTM International (ASTM):

1. E10 Standard Test Method for Brinell Hardness of Metallic Materials

2. E94 Recommended Practice for Radiographic Testing

D. American Welding Society (AWS):

1. B2.1 Specification for Welding Procedure and Performance Qualifications

2. D1.1 Structural Welding Code

1.03 SUBMITTALS

A. Rail Material Schedule: Within 30 days of receipt of Notice to Proceed, and prior to the delivery of the rail to site, submit a complete schedule of all Contractor-furnished rail materials proposed for installation, source of the rail, and product information including rail section, length, and date rolled.

B. Product Data: Submit the following product data for rail:

1. Manufacturer's Catalog Data

2. New Rail Product Analysis

3. Rail Ultrasonic Test Report

C. Quality Control Program (QCP): Submit rail manufacturer's quality control

program.

D. Storage Plan: Submit a storage plan for each storage area where Contractor-furnished rail is proposed to be stored or stockpiled. Include sufficient detail to demonstrate that efficient handling and security provisions will be provided, that supporting soils will not be overloaded, and that materials will not be overstressed due to bending or shear.

E. Within 30 days of rail delivery, submit rail storage layout showing the precise location of each individual piece of rail, identified by the unique heat number.

1.04 DELIVERABLES

A. Certificate of Compliance that the rail furnished meets all requirements set forth in this Section.

B. Mill certificate, and quality control inspections and shipment records including:

1. Chemical analysis of the rails shipped, listed by heat number, and the specified chemical analysis elements.

2. Brinell hardness of the rails shipped by heat numbers, and the hardness pattern for hardened rails as applicable.

3. The method of hydrogen elimination.

4. A shipping statement of the rails shipped which will include the number of pieces of each length, and the total tons shipped in each vehicle (rail car or ship).

5. A statement that all rails supplied meet the ultrasonic requirements with supporting inspection records.

6. A statement that all macroetched samples representing the rails supplied meet the Macroetch requirements with supporting inspection records.

1.05 QUALITY ASSURANCE

A. Manufacturer's Quality Control Program (QCP) shall be in accordance with the AAR M-1003 or Engineer approved equivalent quality control program.

B. Comply with AREMA Portfolio of Trackwork Plans.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Quality Control Program (QCP) shall be in accordance with the AAR M-1003 or Engineer approved equivalent quality control program.

B. CWR shall be transported on special purpose rail cars and be delivered in a manner which will prevent damage to the CWR. Submit procedures, equipment, and information for the loading, unloading, handling and storage.

C. Handle rail with roller, tongs or other methods that will not result in damage to the rail. Do not drop rail nor leave it unevenly supported.

D. Move CWR on rollers, buggies or other means to fully support it. Do not drag along the ground or across crossties.

E. Store rail in a designated site under the direction of the Engineer if not used for construction within 6 months of delivery.

PART 2 - PRODUCTS

2.01 GENERAL

A. Refer to Section 01600, Materials, for general requirements for Owner-furnished materials and for list of Owner-furnished materials, as applicable.

2.02 136 RE CONTINUOUS WELDED RAIL (CWR)

A. Contractor to furnish all rail.

B. Contractor-furnished CWR shall be new 136 RE, Premium Head Harden Rail, control cooled or vacuum treated carbon steel tee rail meeting AREMA Manual, Chapter 4, Section 2.1, Specifications for Steel Rails. Contractor-furnished CWR shall have been rolled within the year prior to shipment.

C. Rail ends shall be field end hardened in accordance with AREMA Manual, Chapter 4, Article 2.1.17.1 "Supplementary Requirements", at all rail end locations not eliminated by welding, including all insulated joints.

D. If the Contractor-furnished CWR are in sections instead of strings, CWR shall be manufactured on-site by flash butt welding rail sections in nominal 80 ft length into 1440 ft strings as specified in Specifications Section 20710, Flash Butt Rail Welding.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Prior to installation, perform visual inspection for presence of any defects in rail being installed including rail furnished by the Owner. Inspect rail as it is being installed.

B. Notify the Engineer of any suspected defects in any rail. Remove rail that is damaged or defective, including wear and corrosion, and clearly mark and place it by the rail bed. Communicate to the Engineer and Contractor's employees whichever means the Contractor uses to mark defective rail.

3.02 INSTALLATION, CUTTING AND DRILLING OF RAIL, AND REMOVAL OF DEFECTIVE RAIL

A. Install rail as specified in Section 20400, Track Construction.

B. Cut and drill rail as specified in Section 20400, Track Construction.

C. Replace rail which has been installed but which is found to be defective, including isolated defects, as specified in Section 20400, Track Construction.

END OF SECTION

SECTION 20200

TRACK REMOVAL AND SALVAGE

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes specifications for salvage and removal of existing track, special trackwork, and other track materials (OTM).

B. The work of this Section may require signal support and testing if removal of existing track involved signal equipment and components.

1.02 REFERENCE STANDARDS

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

1. Manual for Railway Engineering

2. Caltrain Standard Procedures for Track Maintenance & Construction (SPTMC)

1.03 SYSTEM DESCRIPTION

A. Perform work on this Section in accordance with applicable provisions of the AREMA Manual.

B. Engineer has the right to review and inspect all records and reports for track material salvage and removal at any time between commencement and completion of the Work.

1.04 SUBMITTALS

A. Submit proposed salvage and removal methods and schedule, including personnel and equipment; schedule shall be consistent with SSWP specified in Section 01011, Work Planning.

B. Submit product data for marking paint.

C. Submit completed Track Material Inventory forms for all salvaged and removed materials except ballast. See Attachment 20010-A, found at the end of this Section.

1. Include completed inventory forms for turnout components including ties. Utilize forms similar to the attached form, as required and accepted by the Engineer.

PART 2 – PRODUCTS

2.01 DUNNAGE

A. Pallets, sills, and other materials used for packaging and stacking of unused salvaged track items shall be clean, free of decay or other defects, and sufficiently sturdy for the service intended.

2.02 MARKING PAINT

A. Marking paint shall be a good quality spray marking paint or a good quality paint marker as approved by the Engineer.

PART 3 – EXECUTION

3.01 VERIFICATION

A. Prior to commencement of removal and salvage, verify the removal and salvage quantities and storage locations.

3.02 SALVAGE AND REMOVAL OF TRACK MATERIALS

A. Salvage timber ties as indicated in the Contract Scope of Work or Contract drawings.

B. Salvage turnouts as indicated in the Contract Drawings.

C. Salvage joint bars, tie plates, bolts, nuts, washers and anchors (OTM) for re-use as indicated in the Contract Scope of Work or Contract drawings.

3.03 SALVAGE OF CWR TRACK

A. Salvage existing continuous welded rail (CWR) as indicated on Contract Drawings for track construction. Reuse where indicated; if reuse is not required, rail may be cut to manageable lengths and haul to storage area and stockpile as specified herein or as directed by the Engineer.

B. Handle rail by roller tongs or other methods that will not result in damage to the rail. Do not drop rail on the ground nor leave them unevenly supported.

C. Move CWR on rollers. Do not drag along the ground or across crossties.

D. Do not cut salvaged CWR unless authorized by the Engineer. Cutting of CWR is permitted only for fitting within limits of track construction, or when reuse is not required. Use only rail saw or abrasive rail cutting wheel to cut CWR. Other methods for cutting rail will not be accepted. Cuts shall be square and clean.

E. A single handling hole may be drilled in the ends of CWR. Drill hole at 9 inches or 15 inches from the end of the rail to suit joint bar hole spacing. Remove hole prior to installation of CWR. Drilling and cutting rail as described in Section 20400, Track Construction, under Drilling and Cutting of Rail.

F. Remove ties, tie plates and other OTM not suitable for reuse as determined by the Engineer.

3.04 SALVAGING TRACK IN PANELS

A. If approved by the Engineer, in areas of existing CWR, the Contractor will be required to temporarily replace the CWR with 39 feet long jointed rail. The jointed rail shall be installed with squared joints in order to remove the track in panels. The removed CWR shall be handled in accordance with Caltrain Standard Specifications, so as to prevent damage to the rail. Existing CWR will generally be reused unless otherwise indicated in the Contract Drawings or directed by Engineer. CWR shall not be cut unless authorized by the Engineer.

B. In areas of existing jointed rail, which is staggered, the Contractor will be required to square up the rail joints in order to remove the track in panels. This will require cutting and moving of the rail on one side of the track.

1. Do not torch cut rail or holes. Rail sections less than 15 feet in length are not allowed.

2. Rail joints must be bolted with at least 4 bolts, 2 per rail end. Broken bolts must be replaced when found, and all bolts must be kept tight allowing no vertical rail movement in the joints.

3. All trackwork done as required to remove existing track in panels shall be performed in accordance with Caltrain Standard Specifications.

4. Do not reuse existing rail anchors. Install new rail anchors on the jointed rail based on the anchoring pattern specified in Caltrain Standard Drawings. Prior to panel removal, install two (2) anchors per tie to the shoulder and joint ties with full bearing against the side of tie. Do not overdrive, as this may fracture or spread the metal, resulting in less holding power. Replace any rail anchor that is fractured or spread.

3.05 CLEANING OF TRACK MATERIALS

A. Sufficiently clean and then inspect track materials, except ballast, designated for salvage or reuse to ensure that no damage or significant corrosion exists.

B. Clean rail and joint bars by hand or mechanical means to remove dirt, and sort and haul them to the storage area indicated on the Contract Drawings or designated by the Engineer.

3.06 STORAGE AND HANDLING OF SALVAGED TRACK MATERIALS

A. Prevent damage to salvaged materials during salvage operation, handling, and storage.

B. Properly stack or contain salvaged track materials, in a neat fashion at the storage area designated by the Engineer.

C. Where specifically required in the Contract Documents or when required by the Engineer, clean and set salvaged continuously welded rail (CWR) at least 15 feet

from the nearest rail. Requirements for storage of salvaged track materials shall apply.

D. Rail: Segregate salvaged jointed rail by rail section and length. Support bottom layer of rail on crossties evenly spaced. Locate rail piles in well drained sites with base of rail separated from ground surface. Separate each layer by at least three 2 x 4 inch wood strips evenly spaced for each 39 feet of rail. Stack rail in pyramid form with each tier of rail to be offset inward by one half the width of the rail base. Stacks shall be maximum height of 4 feet and maximum width of 15 feet at the base or as directed by the Engineer. Stack rail with the heads up and with the rail ends square and even. Locate rail stacks in areas safely accessible by forklifts, cranes with rail tongs, and other equipment.

E. Turnouts: Disassemble, clean, palletize, box, place in drums salvaged turnouts, securely to prevent loss and damage during transport and storage. Clearly mark the contents of each individual package with a securely attached, weatherproof label.

F. Joint Bars: Sort joint bars by rail section and joint bar length, and stack on pallets. Steel band each pallet for forklift handling.

G. Tie Plates: Sort by size (length and rail base width), stack, and band on pallets for forklift handling.

H. Nuts, Bolts, and Washers: Sort and store in nylon sacks and on pallets.

I. Timber Ties, General: Stack crossties neatly and securely in bundles of 12 (3 ties high, 4 ties wide), band with three 1-1/4 inch bands, and space evenly for forklift handling. Plug all spike holes with tie plugs. Stack to a maximum of 3 bundles high and stockpile at the storage area shown on the Contract Drawings or where designated by the Engineer.

J. The maximum weight of any pallet with any material shall be 1,500 pounds.

3.07 REMOVAL OF TRACK MATERIALS

A. Where track and track materials are designated on the Contract Drawings or specified in this Section to be removed, remove from the work site and dispose of in accordance with the Contract documents.

ATTACHMENT FOLLOWS

ATTACHMENT 20200

INVENTORY OF MATERIALS SALVAGED, STORED, REUSED, AND REMOVED

Item No.	Item (Description)	Location Removed	Quantity	Unit	Date Removed	Date Placed in Storage Area	Quantity Reused	Location Used	Date Used	Remarks

END OF ATTACHMENT
END OF SECTION

SECTION 20300

TIMBER CROSSTIE REPLACEMENT

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for timber crosstie replacement.

1.02 GENERAL

A. Section 01005, Contractor's Personnel and Equipment: Includes general requirements and submittals regarding railroad construction equipment used for work of this Section.

1.03 REFERENCE STANDARDS

A. Caltrain Standard Drawings

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

1. Manual for Railway Engineering

1.04 DEFINITIONS

A. Crosstie replacement generally refers to work areas of 500 track feet or longer, where rate of tie replacement consists of replacing an average of 400 crossties per mile of track, between the limits indicated on the Contract Drawings, and as required by the Engineer. The actual rate may vary, plus or minus 200 ties per mile of track. No tie replacement will be required through the limits of at-grade vehicular or pedestrian crossings.

1.05 SYSTEM DESCRIPTION

A. Perform work on this Section in accordance with applicable provisions of the AREMA Manual.

1.06 SUBMITTALS

A. Submit diagrams showing location and function of each person and each piece of equipment in the tie gang.

B. Submit plan and schedule for removal of existing ties, installation of new ties, and handling of all ties. This submittal shall be consistent with plans and schedules of Sections 01011, Work Planning, and 01310, Schedules.

1.07 DELIVERABLES

A. For crosstie replacement work, submit an as-built track alignment report with tabulation of the vertical and horizontal positions of the prework track alignments and of the postwork track alignments. Pre-work as-built shall be taken within 48

hours of crosstie replacement work. Post-work as-built shall be taken after the completion of surfacing and stabilizing activities and prior to return to service.

PART 2 - PRODUCTS

2.01 CONTRACTOR-FURNISHED MATERIALS

A. Furnish ties, spikes, and superelevation tags compatible to each of the existing track and as specified in the Contract Documents.

B. Refer to Section 20130, Timber Crossties and Switch Ties, for timber ties replacement work.

C. Refer to Section 20110, Ballast and Walkway Aggregate, for ballast for crosstie replacement work.

PART 3 - EXECUTION

3.01 INSPECTION

A. Prior to commencement of the crosstie replacement work, inspect and verify areas indicated on Contract Drawings, marked in the field, or as required by the Engineer for crosstie replacement.

3.02 GENERAL

A. Replace defective ties as marked by the Engineer, and in the quantities identified in the Contract Documents and within the Contract limits.

B. Perform work in such manner to best utilize time allowed under the available working time limits.

C. Perform work in accordance with applicable parts of Section 20400, Track Construction, except as modified or amended herein.

3.03 PRODUCTION CROSSTIE REPLACEMENT

A. Refer to Section 01011, Work Planning. Assign work crew and equipment capable of installing a minimum of 50 ties per 6-hour work window.

B. Remove existing crossties without excessively splintering them. Dispose of these crossties including associated debris in accordance with GC7.15, Disposal of Material Outside of the Work Site. Do not raise or hump the track when removing ties. Remove debris from crosstie renewal prior to surfacing operations.

C. Remove and dispose of existing cut spikes and rail anchors. Excavate the tie cribs and end so that the old ties can be removed and new ties installed without jacking the rails, or otherwise distorting or humping the track. Repair any track that is distorted or humped as a result of Contractor's operation.

D. Reuse existing tie plates with the following exception: Worn, bent or cracked plates and plates less than 14-inch long shall be replaced with new plates.

Position plates so that the batter of plate will cant rail to gauge side and be centered over the width of the tie to obtain proper bearing of rail. Ensure that outside (field side) shoulders of tie plates have full bearing against base of rail. Set spikes with a self-propelled driver/setter machine.

E. Center tie plates over the width of the tie, except that the plate shall be positioned up to 1/2 inch off-center if necessary to avoid spiking into an existing tie split.

F. Use the standard spiking pattern in the Caltrain Standard Drawing SD-2221. Keep respiking of new timber ties to a minimum. Replace ties that have been excessively respiked, as determined by the Engineer, or ties that have been respiked due to the Contractor's carelessness.

G. Replace 50% of existing anchors with new ones. Install anchors tight against the tie.

H. When replacing crossties with resilient fastening system, reinstall resilient fasteners in accordance with the requirements of Section 20400, Track Construction.

I. Place new crossties square to the line of rail spaced on 19 1/2 inch centers. Crosstie position at joints shall result in a "suspended joint", with new ties spaced so that center of the space between ties will coincide with center of joint bars.

J. Prior to completing work for the day, line and tamp all newly installed crossties with a switch/pup tamper. Switch/Pup tamper shall be Jackson 3300 pup tamper or similar. The tamper to be used will be subject to approval by the Engineer.

K. Newly installed crossties shall receive two (2) or more full insertions of the tamping heads and shall result in the full bearing of the bottom of the tie to ballast. Ties shall be tamped from a point 15 inches inside of each rail on both sides of the ties to the end of the ties. Tamping is not permitted at the centers of the ties to avoid center bound track. Two tamping tools shall always be worked opposite each other on the same tie. Replenish ballast as necessary with new mainline ballast.

L. Install superelevation tags on completed ballasted track in accordance with Caltrain Standard Drawings.

3.04 FIELD QUALITY CONTROL

A. After completion of tie replacement, perform inspection on post-work track condition. The crosstie replacement work is not accepted as complete until the Engineer has checked and verified the final track condition.

B. Refer to deliverables specified herein for reports required in connection with completion of tie replacement work.

END OF SECTION

SECTION 20400
TRACK CONSTRUCTION

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes specifications for track construction, surfacing existing track and turnout, and shifting and/or raising existing track.

1.02 REFERENCE STANDARDS

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

1. Manual for Railway Engineering

2. Portfolio of Trackwork Plans

B. Caltrain Standards and CWR Plan

C. Federal Railroad Administration (FRA) Code of Federal Regulations (CFR), Title 49, Subtitle B, Chapter 2:

1. Part 213, Track Safety Standards

2. Part 214, Subpart D On-Track Roadway Maintenance Machines and Hi-Rail Vehicles

D. Applicable General Orders of the California Public Utility Commission (CPUC)

1.03 SYSTEM DESCRIPTION

A. Trackwork shall be constructed in accordance with the Contract Documents and the above-mentioned Standards.

1.04 SUBMITTALS

A. Submit plan for handling of materials and construction of tracks for Engineer's approval. Plan shall include proposed equipment used to line, surface, tamp, and stabilize the track structure; regulate and sweep ballast.

B. Methods and equipment proposed for achieving required thermal stress in the CWR that meeting Caltrain CWR Plan.

C. Plan for providing a signal support crew to protect and maintain the operating signal system. Refer to Section 01005, Contractor's Personnel and Equipment, for related submittals.

D. If the Contractor proposes alternate construction staging plans, submit plans for the prior approval of the Engineer.

E. Submit plan for surfacing, regulating ballast and stabilizing the track structure, including equipment and methods.

1.05 DELIVERABLES

A. Submit rail temperature and fastening records on forms furnished by the Engineer for CWR installation.

B. Submit the following prior to starting track construction:

1. Reports of test results and documents, confirming subgrade material, compaction, slopes, grades, and drainage meets Contract requirements.

2. Survey documenting facilities within the track subgrade and their condition prior to starting track construction.

C. Prior to beginning track construction, submit a report confirming the constructability of the Work based on the construction staging plans as indicated in the Contract Drawings.

D. Submit rail fastening record forms to the Engineer before the end of the shift during which CWR was installed.

E. Submit report confirming that track is ready for tamping, lining, and surfacing.

F. Submit an as-built report with tabulation of the vertical and horizontal positions of the final track alignment to the Engineer for final acceptance of the track. As-built survey shall be taken after the completion of all trackwork, including surfacing and stabilizing activities. Tabulated data shall include columns and data for all trackwork tolerances as listed in paragraph 3.12 of this section.

1.06 QUALITY ASSURANCE

A. Qualifications: Manufacturer of track materials shall have successfully furnished track materials to Class 1 Freight, Passenger or Commuter Railroad. This does not include transit or light rail special trackwork. Track materials shall be new unless otherwise noted on in the Contract Documents to be used or second hand.

B. Regulatory Requirements: Comply with the following:

1. FRA 49 CFR Part 213 and Part 214

2. Applicable General Orders (G.Os) of the California Public Utility Commission (CPUC)

C. Submit documentation showing qualification of supervisor managing the track construction, training and certifications for welders, operators, and testing firms.

D. Submit Plans and Schedules.

E. Submit Material Safety Data Sheets.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Replace damaged crossties, rail, other track material (OTM), and fastener assemblies. If track is constructed with track panels, inspect track panels and rail and store in a designated area within the work site prior to installation.

PART 2 – PRODUCTS

2.01 CONTRACTOR-FURNISHED MATERIALS

A. Furnish all materials, equipment and labor required to complete all aspects of the track construction work as specified and shown in the Contract Documents except for Owner-furnished materials, equipment and labor. Refer to Sections 01004, Owner Furnished Labor and Equipment, and 01600, Materials.

2.02 OWNER-FURNISHED MATERIALS

A. Refer to Section 01600, Materials for description of Owner Furnished Materials.

B. Salvaged track materials indicated on the Contract Drawings and specified Section 20200, Track Removal and Salvage, shall be considered as Owner-furnished materials if indicated for reuse in track construction.

PART 3 – EXECUTION

3.01 PREPARATION

A. Prior to commencement of trackwork construction, check the track subgrade as to line, grade, and cross section, and compaction. The track subgrade lies below the ballast section, supports the track structure, providing the base structure for the track, and ballast in addition to providing the slopes and grades for drainage of the track. The track subgrade shall not vary from the design elevations and the line cross sections from the range of plus or minus 1/2 inch.

1. Correct subgrade settlement discovered by repairing the subgrade as specified in Section 02300, Earthwork. Unless otherwise noted, relative compaction of subgrade shall not be less than 95 percent as determined by ASTM D1556.

2. Place and compact subballast in accordance with the requirements of Section 02300, Earthwork.

3. Submit to the Engineer a report confirming that all requirements for the subgrade are met according to the plans and as specified in Section 02300, Earthwork.

3.02 INSPECTION

A. Survey and document the condition of facilities in the track subgrade, including buried conduits, conduit stub-ups, ductbanks, underdrains, and underground utilities. Incorporate the information in a report and submit to the Engineer prior to starting track construction work, operating heavy equipment, and allowing construction vehicles on the track subgrade.

3.03 GENERAL

A. Refer to Section 01011, Work Planning, for plans and procedures regarding work both within and outside the railroad operating environment.

B. Protect facilities in, under, or on the track subgrade during track construction. Repair damages to the facilities which are caused by the Contractor's operations and are not pre-existing as indicated in the Contractor's survey report.

3.04 TRACK CONSTRUCTION

A. Track construction shall include main line track construction, non-main line track construction, raise and shift track, stabilizing, and lining and surfacing track.

B. Main line track construction as indicated in the Contract Drawings shall include placing ballast, placing ties, installing continuously welded rail (CWR), installing insulated joint plugs, installing OTM, de-stressing rail, lining track, surfacing track, regulating ballast, and stabilizing track.

C. Non-main line track construction as indicated in the Contract Drawings shall include placing ballast, placing timber ties, installing second hand CWR or jointed rail, installing OTM, lining track, surfacing track, destressing of rail, and regulating ballast.

D. Raise and shift of main line track or siding track as indicated in the Contract Drawings shall include raising and shifting track to the final alignment, placing ballast, replacing damaged or defective ties, fastening loose ties, replacing worn, broken or missing plates, anchors, spikes, or elastic fasteners, lining track, surfacing track, regulating ballast, and stabilizing track.

E. Lining and Surfacing track as indicated in the Contract documents shall include minor or production track raising and surfacing, with track raise of 1″ to 2″ maximum and track alignment of ½″ to 1″ to correct any deviations from design alignment and profiles, replacing and regulating ballast as required and stabilizing track structure.

F. Lining and Surfacing of track shall include at least 200 feet of track surfacing beyond the limits of track construction, turnout replacement, grade crossing replacement or reconstruction, or of any track work requiring surfacing.

3.05 SEQUENCE OF THE WORK

A. Schedule track construction work according to the requirements of Section 01040, Track Hours and Track Access.

B. Schedule work in such a manner so that the best use of time under the allowable working time limits is made. Make arrangements to ensure that the materials, equipment and labor needed are planned and in place, including signal and traction power support crew.

C. Refer to the construction staging plans, if applicable, in the Contract Drawings for the track construction work and other work that require relocating or reconstructing trackwork.

D. Prior to construction, review the construction staging plans to ensure the constructability of the construction. Refer to submittals and deliverables specified herein for submittal requirements.

E. Track shall be constructed, brought to final line and grade, and fully ballasted before CWR is thermally adjusted.

3.06 INITIAL LAYER OF BALLAST

A. Place an initial layer of ballast, compact it over prepared subgrade prior to placing track or raising and shifting track.

B. Limit initial layer of ballast to a total compacted depth that will establish the track at an elevation between four (4) inches and six (6) inches below final top of rail elevations as indicated in the track profile of the Contract Drawings.

C. Each lift of initial ballast layer shall not exceed a maximum of four (4) inches in thickness and shall be uniformly spread and compacted with a minimum of four (4) passes with vibratory compactor, unless otherwise approved by the Engineer.

D. Place the initial layer of ballast for ballast deck bridges directly over the waterproofing membrane. Protect the waterproofing membrane and deck drainage pipes.

E. Level the surface of the initial ballast layer and compact uniformly prior to crosstie distribution or track installation.

3.07 CROSSTIE DISTRIBUTION AND ADJUSTMENT

A. Distribute and place ties in their final locations. Install ties perpendicular to the track alignment based on the required tie spacing as indicated in Caltrain Standard Drawings.

B. Position cross ties at joints or welds so that a "suspended joint" arrangement results unless otherwise required by the Engineer.

C. Place ties within plus or minus 1/2 inch of required spacing. Discrepancies shall not be additive.

D. Place ties with the heart wood down and ensure the bottom of each tie fully supported on the initial ballast layer.

E. Replace damaged and defective ties.

F. Before laying rail, ensure pads, insulators are properly placed, and clean the wearing surface of the tie and tie plate of any debris.

G. For existing timber crossties that are to remain in service, remove spikes and plug holes. Adjust and reinstall tie plates to achieve 56 1/2" gage. Drive spikes in accordance with Standard Drawing SD-2221.

H. When relaying rail on existing concrete tie track, all tie pads, clips, and insulators shall be replaced.

I. Secure screw spikes at right angles to the tie surface, straight down.

3.08 CUTTING AND DRILLING OF RAIL

A. Use only approved rail saw and abrasive cutting wheel for cutting rail. Cuts shall be square and clean. When given the option of cutting existing rail or cutting the rail being installed, cut the existing rail. Do not use cutting torches on rail; rail cut with torches will be rejected.

B. Drill new holes with a proper template. Do not punch, slot, or burn with torch. Mark and drill each hole location at centers, size, and location shown on the Caltrain Standard Drawings. Peen drilled bolt holes or grind to remove sharp edges. Chamfer holes and rail ends in accordance with Caltrain Standard Drawings. Tolerance for diameter of drilled bolt holes is plus or minus 1/16 inch.

C. For temporary joints on CWR or to use in pulling continuous welded rail (CWR), drill a single hole in the end of the CWR at 9 or 15 inches from the end of the rail. When installing temporary joints drill the two outer holes for the six hole angle bars.

3.09 LAYING AND INSTALLING CONTINUOUSLY WELDED RAIL (CWR)

A. Laying CWR:

1. Lay CWR in-place in a manner that does not damage rail, crossties, tie plates, fasteners, pads, insulators, or other appurtenances. Ensure that surface of tie plate or tie pad is free of ballast or other material that would prevent full bearing of the rail on the tie plate.

2. Install prefabricated insulated joint rail plugs at locations as indicated in the Contract Drawings. End post insulation shall be centered in the tie crib closest to the specified location. Cut the CWR string at the location where the end of the bonded insulated rail will end and then pull the CWR the required distance to install the insulated bonded joint rail, do not cut a section of the CWR to install the bonded rail.

3. Bonded insulated joint rails shall be a minimum of 39’ in length when installed on curved track.

4. Determine the rail temperature by means of an AREMA standard rail thermometer as specified in the AREMA Manual. Connect CWR strings with temporary joints. Temporary joints shall be jointed with six hole angle bars and secured with the four outer bolts, refer to standard drawings on 6 hole angle bars requirements. Temporary joints shall be welded within 30 days of installation.

5. Heat the rail as specified herein to the following required Desired Neutral Temperature Ranges (DNTR): CWR shall be installed within 5 degree of the Desired Neutral Temperature (DNT) of 105 degrees F.

6. If the rail temperature exceeds the maximum specified for that area, the Engineer reserves the right to suspend rail laying operations or require that the rail be cooled.

7. Distribute and position CWR for fastening in a manner to minimize handling over tie pads, or tie plates and to prevent buckling. Use rollers to move strings of CWR. Do not drag CWR along the ground or along crossties.

8. Place rails base down, parallel to the track and at a sufficient distance where it will not be struck by passing trains or equipment. Rail and rail ends must be secured to prevent movement towards the track. Avoid placing rail over bridges, bride walkways, structures, manhole covers, electrical connections or near other installations that could be susceptible to damage or cause damage to the rail, avoid bending or damage to the rail, use the appropriate rail handling equipment.

9. In advance of the rail fastening, determine rail temperature. Place thermometer on web or base of rail shaded from the sun, long enough to record the rail temperature accurately. Check and record rail temperature every 30 minutes during laying.

10. Do not cut rail strings except as required, or for installation of turnouts, crossovers, and other special trackwork.

11. Position CWR strings so that tie-in welds are staggered by a minimum of 15 feet, unless otherwise approved by the Engineer.

12. Place welds at 25 feet minimum from the edge of grade crossing panels and stagger by a minimum of 15 feet.

13. Pieces of rail longer than 15 feet shall remain the property of the Owner. Pieces of rail shorter than 15 feet shall be removed and disposed.

B. Rail Ends:

1. Cut rail to a tolerance of 1/32 inch from square. Remove burrs and make ends smooth. On rail ends that will remain as jointed rail ends, chamfer edges in accordance with Caltrain Standard Drawings.

2. Rail end mismatch on the running surfaces shall be ground to 0" Tolerances.

3. Rail batter is the distance in 1/1000 inch, between the bottom of the straight edge 24 inch long, applied along the centerline of the worn surface of the top of the rail. Limit welding to joints where one rail shows a batter of 1/16 inch or more. Where rail ends are not battered to an extent requiring welding, but where measurement shows a difference in the height of the rails of 1/16 inch or more, build up the low rail to the height of the high rail. Do not make welding repairs past the end of the joint bar or end repairs over a bolt hole.

C. Fastening CWR:

1. Install resilient fasteners or rail anchors, only after the rail has achieved a temperature within the specified range and has been de-stressed in accordance with Caltrain CWR plan.

2. Fasten rail only when its temperature is within 5 degrees F of the opposite rail's fastening temperature.

3. Prior to de-stressing rail, remove any joint bars or compromise joints installed at the Contractor's convenience and replace by thermite weld.

4. At the time of joining CWR strings by welding, ensure that the rail has been adjusted to the desired neutral temperature as specified in Caltrain CWR plan.

D. Adjustment by Heating:

1. Heat rail with an approved rail heater when installing rail with a rail temperature lower than the specified minimum for that area. Rail lengths of 200 feet or less may be adjusted by a rail puller. For rail lengths over 200 feet, use a rail heater.

2. Adjust rail temperature after it has been laid but before it is fastened or anchored, as applicable. Rail shall not be thermally adjusted before the track is constructed to final line and grade with a full ballast section.

3. At the time of welding, provide a gap at the end of each continuous welded rail equal to the amount of the expansion that is required for that rail plus the required gap for the weld.

4. Begin heating at the end of the rail and steadily apply moving forward without reversing direction until the required temperature range (Desired Neutral Temperature) has been achieved for that rail. Control uniformity of expansion by marking each quarter of the string and introducing expansion as follows:

1/4 Point	1/4 of total required expansion
1/2 Point	1/2 of total required expansion
3/4 Point	3/4 of total required expansion
4/4 Point	4/4 of total required expansion

a. Mark quarter points with a continuous line from the base of rail to the tie plate or shoulder of concrete tie so that the amount of expansion can be accurately determined. The reference shall be one that will not move as the rail expands.

5. Vibrate the rail along its entire length during heating or after it has achieved zero stress temperature to facilitate the relieving of internal rail

stresses (destressing). Use only appropriate vibrators as approved by the Engineer. Do not strike the rail with objects which might damage the rail.

6. The fastening operation shall immediately follow destressing. Fastening of the rail shall occur within the temperature range as specified in this Section.

E. Gaps for Rail Distribution Adjustment:

1. During rail laying below the indicated zero thermal stress or desired temperature, determine the gap between CWR strings by using the following equation:

$$G = (t - T)LK + Q$$

G = Required rail gap (inches)

t = Desired Neutral Temperature (DNT) in degrees F

T = Actual rail temperature at time of laying in degrees F (before heating)

L = Length of rail in feet (total length of unrestrained rail)

K = Coefficient of thermal expansion for rail steel (0.000078 inch per foot per degree F)

Q = Rail gap as required by manufacturer of field weld kit in inches

2. The Desired Neutral Temperature used in the formula above shall be 105 degrees F.

F. Rail Fastening Record:

1. Provide in an acceptable, reproducible, and separate form during installation the following data for each end of a CWR or at each 500 foot interval for rails longer than 1,500 feet:

a. Date and time

b. Track number (i.e. MT1) and rail (left or right looking up-station or milepost)

c. Railroad stationing

d. Weather, air, and base of rail temperature; the base of rail temperature shall be recorded every 30 minutes.

e. Type of fastener used

f. Length of rail being anchored or fastened

g. Record all individual heat numbers in the rail string.

3.10 LAYING AND INSTALLING TRACK PANELS OR JOINTED RAIL

A. Installation and placement of track panels or jointed rail:

1. Place track panels on initial layer of ballast according to the final horizontal alignment as indicated in the Contract Drawings.

2. Place each sequential track panel close enough to install joint bars with minimal sliding or handling of track panels.

3. Place tie plates under rails on all crossties. Clean tie plates and center them on the tie so that the rail will have full bearing on the plate and the plate will have full bearing on the tie. Set tie plates at right angles to the rail with the outside shoulder having full bearing against base of the rail.

4. Lay rail with staggered joints. When constructing jointed rail track without using track panel, stagger the joint by minimum 5 ft but not more than 15 ft. For track panel construction, the joints in each line of rail shall be not more than 30 inches from the center of the opposite rail on tangents and curves up to 6 degrees, or more than 4 feet on curves over 6 degrees. Rails of less than standard length shall be used to space the joints on curves.

5. Adjust rail with squared joints in track panels so rail joints will be staggered as required for jointed 39’ rail construction above.

6. When drilling new holes, chamfer and remove chips and burrs from rail drilling in accordance with Caltrain standard drawings before installing joint bars. Rail end drilling shall be per Caltrain standards and match joint bars.

7. Gap rails at time of laying, before joint bars and bolts are installed, in accordance with the following table for 39-foot rail:

Rail Temperature (degrees F)	Expansion (inches)
Below 6	5/16
6 to 25	1/4
26 to 45	3/16
46 to 65	1/8
66 to 85	1/16
Over 85	0

8. Completely bolt joint bars with all bolts torqued. Use expansion shims to provide proper rail gap. Use an AREMA standard rail thermometer to determine the thickness of shims in accordance with the

recommendations in "Temperature Expansion for Laying Rails" Chapter 5 Part 5 of the AREMA Manual.

B. Properly apply joint bars with full number and correct size of bolts, nuts and spring washers. Properly tighten joint bolts before spiking rail; tighten the two center bolts in advance of the end bolts. Except insulated joint bars, coat all joint bars on the rail fishing areas with approved track grease prior to assemblage. Similarly, clean all rail ends with a wire brush and apply grease in the areas of joint bar contact.

C. Place bolts with the nuts alternately on the inside and outside of the rail. Place nuts with the flat side toward the rail. Lubricate track bolts. Check rail ends for mismatch. Rail end mismatch shall be welded or ground to 0" tolerance on all running surfaces of the rail prior to placing track in service.

3.11 TRACK TAMPING, LINING, SURFACING AND STABILIZING

A. Tamp, line, surface, and stabilize track as follows:

1. Completely construct, gage, spike, or fasten and bolt track in conformance with the requirements specified in this Section prior to tamping, lining and surfacing. Align track with a full ballast section to the final horizontal alignment as indicated in the Contract Drawings.

2. Check the track on the initial ballast layer to ensure all track components including ballast, tie, rail, and OTM meet the requirements specified in this Section and as indicated in the Contract Drawings. Refer to deliverables specified herein for required report confirming that the track is ready for tamping, lining and surfacing.

3. Perform tamping of track including lifting, lining, and surfacing. The tamper shall meet the following requirements:

   a. The tamper shall be capable of external control of both line and grade and shall be capable of external control of alignment utilizing a laser guidance system.

   b. The tamper shall be an automatic, vibratory, squeeze-type power tamper equipped with fully functional laser liner and 16 tamping heads, capable of raising both rails simultaneously and maintaining cross-level.

   c. The tamper shall be a production type tamper-liner capable of lifting, lining, and surfacing track and turnouts within the specified track tolerances and with the specified ballast.

   d. The tamper and equipment to be used for tamping operations will be subject to approval by the Engineer.

4. Every tie in the track shall receive two (2) or more full insertions of the tamping heads per surfacing pass (when more than one raise is required to bring track to final grade) and shall be tamped from a point 15 inches inside each rail on both sides of the ties to the end of the ties. Tamping

will not be permitted in the center of the tie between the above stated limits. Where raising the track has resulted in a void under the center of the tie, lightly fill the center space. Tamp both ends of a tie, inside and outside of the rail, simultaneously.

5. Accomplish track surfacing by a method that will not cause undue bending of rail, straining of joints, and damaged rail fastenings. Raise both rails at one time and as nearly uniform as possible. Limit each track lift to an amount that will not endanger the horizontal, vertical, and longitudinal stability of the track. The maximum lift shall not exceed 4 inches. Raise the track so that a final lift of not less than one inch or more than 2 inches is necessary to bring the track to proper final grade.

6. Lift all ties that are pulled loose during surfacing operations. Clean plate or tie pad surface of dirt and ballast, plug, spike, or secure with elastic fastener and tamp to provide full bearing against the rail.

7. Surface and align track to the tolerances specified in this Section. The number of surfacing passes shall be as necessary to obtain the required vertical, horizontal alignment and superelevation or cross level.

8. The runoff at the end of raise shall not exceed 1/4 inch in 31 feet of track unless otherwise approved by the Engineer.

9. Tamp ties to provide solid bearing against the base of the rail after the track is raised to grade at final surfacing. Just prior to final dressing, stabilize track with a dynamic track stabilizer. Bring up all down ties to the base of rail and machine tamp. The resultant track surface and alignment shall be uniform and smooth.

10. Stabilize all track with a dynamic track stabilizer or work train as specified in the Contract Documents or required by the Engineer. The dynamic track stabilizer shall meet the following requirements:

    a. The Dynamic Track Stabilizer shall be a well proven machine widely used by the railroad industry and capable of applying controlled, accurate stabilizing forces into the track structure at continuous speeds of up to 1mph.

    b. The track may be stabilized with a work train. Refer to Contract Documents for the requirements for using a work train to stabilize the track.

11. During track tamping and stabilizing, add, re-tamp, and re-compact ballast to maintain the depth of ballast indicated on the Contract Drawings.

12. Upon completion of tamping, surfacing and lining operations, the track shall have been fully ballasted, tamped, surfaced, lined, stabilized, and dressed as shown on the Contract Drawings and specified in this Section.

13. Remove excess ballast from the track. After completion, no ballast shall remain on the tops of the ties, tie plates, or fastening systems.

14. Remove and replace overworked and excessively tamped or compacted ballast as determined by the Engineer.

B. Maintain horizontal alignment during the raising operation. Use automated controls on tampers to satisfy this requirement.

C. Apply rail bonding across any bolted joints in accordance with the requirements in Section 18400, Rail Bonding, and obtain approval of the bonding from the Engineer.

D. Perform welding and de-stressing in CWR after track is surfaced to final vertical and horizontal alignment.

E. Perform tests to ensure the operating signal system has been restored. Obtain approval of signal test results from the Engineer prior to opening the track to service.

3.12 TRACK CRITERIA AND TOLERANCES

A. Construct track to the alignment and grade shown on the Contract Drawings. Gage shall be 4 feet 8-1/2 inches. Completed track shall conform to the following tolerances:

1.	Deviation from correct gage timber ties:	1/8 inch
2.	Deviation from correct gage concrete ties:	1/16 inch
3.	Track Surface	
a.	Runoff in any 31 feet of track at the end of a raise may not be more than:	1/4 inch
b.	Change in cross level or super-elevation over any 31 feet of track may not be more than:	1/8 inch
c.	Deviation from uniform profile on either rail at the mid-ordinate of a 62-foot chord may not be more than:	1/8 inch
d.	Deviation from zero cross-level at point on tangent may not be more than:	1/8 inch
e.	Deviation from design super-elevation may not be more than:	1/8 inch
f.	Difference in cross-level between 2 points less than 62 feet apart on tangents may not be more than:	1/4 inch
g.	Deviation from specified top of rail to top of platform:	+0, -1/4 inch

h. Location of crosstie placement: 1/2 inch

4. Alignment: Maximum deviations for horizontal alignment shall not exceed:

   a. Tangent Track: 1/4 inch at mid offset on a 62-foot chord.

   b. Curved Track: 1/4 inch from correct mid-ordinate on a 62-foot chord.

5. Track shall be constructed to within 1/2 inch of correct horizontal and vertical position as indicated in the Contract Drawings and within the allowable tolerances specified above.

6. Constructed track shall conform to all required tolerances; + (plus) as specified above and – (minus) zero.

7. Combination of track gage and track alignment tolerances shall not be allowed in any one location within 62 feet of a track segment.

3.13 RAISING AND SHIFTING TRACK

A. Perform raising and shifting of existing track and turnouts to permanent new alignments at locations indicated in the Contract Drawings and in accordance with the requirements of these Specifications. Do not shift tracks more than two (2) feet in any single pass on wood ties. Concrete tie track shall not be shifted more than 12” in any single pass. All track shifts shall begin and end in the same direction regardless of amount of track shift or number of passes.

B. Prior to raising and shifting track or turnout, widen the existing trackbed in conformance with Section 02300, Earthwork, as required to provide a full track subgrade in accordance with the typical section indicated in the Contract Drawings.

C After CWR has been removed in accordance with Specification Section 20200. Remove existing spikes and plug holes. Adjust and reinstall tie plates to achieve 56 1/2" gage. Drive spikes in accordance with Caltrain Standard Drawing SD-2221. Reinstall new rail in accordance with article 3.09 of this section. Reposition skewed ties and other track components to their proper spacing and alignment.

D. Destress rails in accordance with article 3.09 of this section and Caltrain CWR Plan.

E. Surface and stabilize track in accordance with article 3.11 of this section.

3.14 REPLACEMENT OF DEFECTIVE RAIL AND DAMAGED RAIL FASTENER ASSEMBLIES

A. Remove and replace rail that has been found to be defective during construction as follows:

   1. In tangent track: with 15 foot minimum length of defect-free rail.

2. In curved track: with 30 foot minimum length of defect-free rail.

3. Field welds shall not be made within 5' of an existing field weld, or across from a field weld on the opposite rail.

B. Weld defect-free rail into the rail in accordance with Section 20720, Thermite Rail Welding.

C. Replace rail fastener assemblies damaged during tamping, regulating or other track construction operation.

D. Replacement rail shall be new. Rail to be installed shall closely match wear of existing rail.

3.15 FIELD QUALITY CONTROL

A. After completion of trackwork construction, check the track alignment as to line, grade, and cross section.

1. Track alignment and profile with errors exceeding construction tolerances specified in this Section shall be corrected by shifting, raising, or lowering the track.

2. Submit to the Engineer as-built report with tabulation of the vertical and horizontal positions of the final track alignment. As-built survey shall be taken after the completion of all trackwork, including surfacing and stabilizing activities. Tabulated data shall include columns and data for all trackwork tolerances as listed in article 3.12 of this section.

3. The track construction is not accepted as complete until the Engineer has checked and verified the final track alignment data submitted by the Contractor.

4. Track construction complies with contract plans and specifications, Caltrain Standards, and Regulations. Punch list items have been completed and signed off.

5. All documentation such as weld, weld testing, rail data, and rail de-stressing have been properly documented and submitted.

6. Special Trackwork such as turnouts or crossover tests shall be documented, as well as all measurements of switch throw, guard rails, and frogs documented and accepted.

B. Upon completion of CWR installation and thermal adjustments, the Engineer may require verification of any segment of rail and the Contractor shall verify that rails are at acceptable neutral stress temps by use of a non-destructive stress free measuring system such as VERSE by VORTOK Int. or accepted equal.

1. Test using the VERSE equipment shall be performed per manufacture's recommendations on each rail at points no more than ½ mile apart on

tangent sections of track and where curvature is no less than 2300' in radius.

2. Any sections of rail found tested to be at a neutral stress temperature outside the range of 100 and 110 degrees F shall be readjusted.

3. Testing must be performed by a person certified in the use of and by the manufacturer of the testing equipment or a firm qualified to perform such certifications. Certification must be submitted to the Engineer.

3.16 TRACK BACK IN SERVICE

A. Complete the Return to Service Report attached at the end of this Section prior to returning track to service. The track construction is not accepted as complete until the Engineer has checked and verified the final track alignment data submitted by the Contractor.

B. Visual inspection must be performed by the contractor, owner, or owner's representative prior to returning track to service. Inspection must be documented in the Caltrain form provided and signed by all parties asserting that the track, track structures, and signal system are safe and secure for rail operations.

ATTACHMENT FOLLOWS

RETURN TO SERVICE REPORT

Inspection is required to restore track to service following any significant work/outage. All involved parties (Contractor, JPB, Rail Operator) shall inspect and verify conditions. Inspectors shall be trained and qualified under JPB SPTM&C rules as well as the applicable regulations, and shall be familiar with the scope and progress of the work involved.

Reason for Outage			
Description of Work			
Date/Time		**Weather/Temperature**	
Location (Station & Milepost)	Track Number/Name	Timetable Speed	Current Speed
Condition/Remarks		Corrective Action Taken	

Track is acceptable for return to service	Yes	No	N/A	Print Name & Date	Signature
Responsible Party	☐	☐	☐		
Contractor Track	☐	☐	☐		
JPB Track	☐	☐	☐		
Operator Track	☐	☐	☐		
Contractor Signal	☐	☐	☐		
JPB Signal	☐	☐	☐		
Operator Signal	☐	☐	☐		

Track Conditions						**Corridor Conditions**				**Stations**		**Bridges**	
Rail	☐	Ties	☐	Fasteners	☐	Excavation	☐	Signals	☐	Crossings	☐	Piles/Caps	☐
Alignment	☐	Gage	☐	Turnouts	☐	Shoring	☐	Crossings	☐	Platforms	☐	Substructure	☐
Surface	☐	Anchors	☐	Crossings	☐	Footing	☐	Clearances	☐	Walkways	☐	Superstructure	☐
Joints	☐	Spikes	☐	Bolts	☐	Falsework	☐	Drainage	☐	Clearances	☐	Ballast Retainers	☐

END OF ATTACHMENT

END OF SECTION

SECTION 20500
SPECIAL TRACKWORK

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for Contractor-furnished and Owner-furnished special trackwork.

1.02 REFERENCE STANDARDS

A. Caltrain Standard Drawings

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

1. Manual for Railway Engineering

2. Portfolio of Trackwork Plans

3. Specifications for Special Trackwork

1.03 DEFINITIONS

A. Special Trackwork: A generic term referring to turnouts, crossovers, track crossings, derails, and similar track items.

1.04 SYSTEM DESCRIPTION

A. Special trackwork shall be configured, fabricated, and installed in accordance with the Contract Documents and AREMA Manual and Portfolio, where applicable.

B. Special trackwork shall be coordinated with signal work. Include coordination of specific signal equipment or components required for special trackwork construction. Refer to Division 18, Signals.

1.05 SUBMITTALS

A. Submit shop drawings prepared using the latest release of AutoCAD at least 30 days before fabrication is scheduled to begin, unless otherwise specified. Submit files in a CD in both Pdf and AutoCAD format. Submit hard copies of shop drawings as specified in Section 01300, Submittals and Deliverables.

B. Submit material data for Contractor-furnished new material.

C. Submit special trackwork packaging method.

D. Qualifications: Submit data documenting each manufacturer's past performance and projects within the last ten (10) years furnishing special trackwork material to Class 1 Freight, Passenger or Commuter Railroad.

E. Staging Plans: Submit plans include assembly locations, transport methods, and equipment used for prefabricating special trackwork outside of the working track.

1.06 DELIVERABLES

A. Manufacturer of special trackwork (for either Owner-furnished or Contractor-furnished) shall provide to the Engineer the following:

1. 2 copies of conformed design in latest AutoCAD

2. 2 copies of as-builts in latest AutoCAD

B. Installation of special trackwork:

1. Submit Manufacturer's certificates of compliance for special trackwork.

2. Certification of Installation: Submit affidavit by the manufacturer's field representative certifying that the installation of the special trackwork meets Manufacturer and Contract requirements.

3. Submit an as-built report with tabulation of the vertical and horizontal positions of the final track alignment.

4. Submit final shop drawings revised to show any variations from the tolerances, dimensions, lengths, or angles shown on the approved shop drawings.

5. Installation of Special Track shall comply with requirements in Section 20400.

1.07 QUALITY ASSURANCE

A. Qualifications: Manufacturer of special track shall have successfully furnished special trackwork to Class 1 Freight, Passenger or Commuter Railroad. This does not include transit or light rail special trackwork.

B. All special trackwork, assemble turnouts, crossovers, and derails shall be inspected in the manufacturer's fabrication shop.

1. Coordinate the details and scheduling of the inspection with the Engineer at least six (6) weeks before the shop assembly inspection. Provide the Engineer with a safe access to the lay down area and assist with the inspection activities as required.

2. Note on the final shop drawings any variations from the tolerances, dimensions, lengths, or angles shown on the approved shop drawings.

3. Submit applicable documentation complying with Section 20400 Track Construction.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Limit the amount of "bundles" for each unit to the absolute minimum possible and indicate in the packaging plan how the materials will be stacked and marked to allow for easy identification of all the components that are part of the same unit.

B. Pack as complete units in secured bundles all turnouts, crossovers, and derails.

C. Mark units, bundles, and boxes clearly with the following information: identification of item contained, Manufacturer's name, shipping date, unit designation (right or left), number of pieces, destination, and gross weight.

D. Handle special trackwork materials in a manner that will prevent breaking, bending, or other damage during packaging, loading, transporting, and unloading. Do not drop or throw materials from cars, but lift or skid to the ground or other surface. Do not sharply strike special trackwork.

E. Transport and handle insulated joints in a manner that will protect them from damage.

PART 2 - PRODUCTS

2.01 CONTRACTOR-FURNISHED TURNOUTS, CROSSOVERS, AND DERAILS

A. Fabricate turnouts, crossovers, and double point split switch derails, including frogs and guardrails, from new materials. Fabricate special trackwork entirely insulated with the proper number of gage plates ahead and behind the extended switchpoints and stockrails and with all other components necessary.

B. Design for turnouts, crossovers, and derails shall conform to Caltrain Standard Drawings. All rail shall be head hardened premium 136# rail or as specified in the contract documents.

C. Special trackwork shall be manufactured from premium head hardened rail.

D. Spring frogs shall conform to Caltrain Standard Drawings or Engineer approved equal. Castings shall be 3-shot explosion-hardened. Rail shall be deep head hardened rail. Frog plates for turnouts and crossovers on concrete ties shall be as required by the manufacturer, and both ties and frog shall be provided as a unit. Bolts shall be 1-3/8 inch Grade 8 square head with 1/4 inch hardened flat washers and hexagon security locknuts. Lubricate frog bolts and torque to 2,500 foot pounds.

E. Railbound Manganese (RBM) frogs with elastic fastening system shall conform to Caltrain Standard Drawings or Engineer approved equal. Manganese castings shall be 3-shot explosion-hardened in accordance with AREMA Specifications. Heel of the frog shall incorporate a 30-degree cut. Furnish frog plates with one inch round holes except as otherwise indicated on the Caltrain Standard Drawings. Bolts shall be 1-3/8 inch Grade 8 square head with 1/4 inch hardened flat washers and hexagon security locknuts. Lubricate frog bolts and torque to 2,500 foot pounds.

F. Unless otherwise noted on the contract documents, turnouts and crossovers shall be fully insulated and welded from the ends of the stock rails through the switchpoints, insulated joints, closure rails and frog area, including all trim rail and beyond the long switch ties where it shall be welded into the existing track or newly constructed track. This includes the welding of the insulated frog gage plates to the guardrail plates.

G. Switchpoints, stockrails, frogs, and trim rail shall have the two (2) outside bolt holes drilled for six hole angle bars to facilitate temporary connections during constructing panelized turnouts and crossovers. Refer to Part 3 of this Section for welding of temporary connections after installation.

H. All switchpoints shall be extended; the turnout switchpoint shall have a replaceable manganese tip, samson undercut, furnished with rollers and have the two outside bolt holes drilled in accordance with Caltrain Standard Drawings.

I. Switch pack with Hollow Steel Ties (HST) shall be used for new #10, #14, and #20 turnouts on mainline tracks. Switch pack shall include, but not limited to, rails, ties, hollow steel ties, blue rods, and all related components to complete the entire switch pack assembly.

J. All stock rails shall be extended, samson undercut and have the two (2) outside bolt holes drilled in accordance with Caltrain Standard Drawings.

K. Boltless adjustable guardrails shall have one inch riser furnished with U69 Guard Bar, complete with four (4) shims per guard-rail plate and fastened with Pandrol "E" clips. Determine the length of guardrail and quantity of guardrail plates in accordance with the switch layout. Furnish guardrail plates with one (1) inch round holes and a 1:40 cant.

L. Provide insulated vertical switch rods with AAR bracket for GRS 5F switch machine for the No. 1 and No. 6 positions, where applicable. Furnish all other vertical switch rod locations without AAR brackets.

M. Insulated Joints:

1. Conform to the requirements in Section 20120, Track Appurtenances and Other Track Material.

2. Incorporate insulated joints into closure rails in order to eliminate additional welds in turnouts and short pieces of rail.

3. Furnish insulated joints in lengths of 19 feet 6 inches minimum, and install them with a minimum stagger of 4 feet 8 inches and a maximum stagger of 10 feet 0 inches.

4. Paint manufacturer's lift locations or center point on the rail head.

5. Provide sufficient clearance on insulated joints for the insulated bar rail and Pandrol E2063B clip to properly fit together.

N. Ties:

1. Nominal tie spacing: 19-1/2 inches (wood) and 24 inches (concrete).

2. Refer to Section 20130, Timber Crossties and Switch Ties, for timber ties for special trackwork.

3. Refer to Section 20140, Concrete Crossties and Rail Fastener Assemblies, for concrete ties for special trackwork

O. Furnish all other track material (OTM) required for construction of turnouts, crossovers, and derails.

P. Furnish signal bonding material and equipment as part of the complete special trackwork items.

2.02 SWITCH STANDS

A. Hand throw switch stands shall be Racor 36-EH switch stand or approved equal. Furnish target as required in SD-2410 with reflective material such as Scotchlite or equal on both sides.

B. Hand throw switch stand for crossovers shall be Racor 36-E switch stand, or Engineer approved equal, furnished with a 36" straight handle providing maximum clearance between tracks. Furnish 8" target of the required color, target material shall be reflective such as Scotchlite or equal on both sides.

C. Hand throw switch stand for double point split switch derail shall be Racor 36-EH switch stand, or Engineer approved equal, in accordance with Caltrain Standard Drawings. Furnish a 14-inch round "D" target with yellow reflective material such as Scotchlite or equal on both sides.

D. Derail sign and posts will be Owner-furnished. Refer to Section 01600, Materials, for related requirements.

2.03 POWER SWITCH MACHINES

A. See Division 18, Signals, for type and installation requirements.

2.04 LUBRICANTS

A. Provide the following types of lubricant or Engineer approved equal:

	Switch Components	Type of Lubricant	Brand/Manufacturer
1	Spring Frogs Wing Rail & Base Plates	Graphite	Slip Plate No. 1 – Superior Graphite Co
2	Switchpoint & Slide Plates	Soy Oil Base	Ultra Green Sprayable – Trac Lubricants & Coatings, LLC
3	Switch Rods & Hand Throw Switch Stands	Grease	
4	M23 Power Switch Machine	Soy Oil Base	Ultra Green Sprayable – Trac Lubricants & Coatings, LLC
5	5F Power Switch Machine	Soy Oil Base	Ultra Green Sprayable – Trac Lubricants & Coatings, LLC
6	A-5 Pneumatic Power Switch	Soy Oil Base	Ultra Green Sprayable – Trac Lubricants & Coatings, LLC
7	M23 Power Switch Machine – Gear Box	Petroleum Lubricating Grease	Lubriplate No. 5555 – Fiske Brothers Refining Co

PART 3 - EXECUTION

3.01 INSPECTION

A. Prior to commencement of special trackwork installation, perform inspection of the following items:

1. Inspect the 8-inch HMAC track underlay and verify its line, grade, cross section, and compaction as specified in Section 02720, Asphalt Paving.

2. In locations where HMAC underlayment is not required, inspect the track subgrade and verify its line, grade, cross section, and compaction as specified in Section 20400, Track Construction.

3. Verify track alignment as to line, grade, and cross section:

   a. Track center distance at crossover locations shall be in conformance with track center distance designed for the crossover. Maximum deviation shall not exceed 1/2 inch of the design distance or alignment.

   b. Track shall be on tangent at locations of the straight side of the special trackwork.

3.02 TURNOUT, CROSSOVER, AND DOUBLE POINT SPLIT SWITCH DERAIL CONSTRUCTION AND INSTALLATION

A. Fully weld turnouts, crossovers and double point split switch derails at joint locations, including both the toe and heel of the frog. Bolt and properly bond

temporary joint locations. Drill only two (2) outside holes on each side at all temporary joint locations. Weld out all temporary joints within 14 days of installation.

B. Dimensions, details and configuration of the turnout, crossover or double point split switch derail shall be as shown on the Caltrain Standard Drawings and the Contract Drawings. Shop drawings of Owner-furnished materials will be provided to the Contractor when they become available.

C. In no case shall a spike or screw spike be within 14 inches of the end of a switch tie.

D. Tracks shall be within 1/2-inch of the designed alignment prior to placing ballast.

E. Switchpoints/stockrails, rail joints, frogs, and other parts of the turnout, crossover or double point split switch derail shall fit together properly and be of the proper match. Allow two (2) inches of clearance between moving parts of the switch and the top of the ballast.

F. Place ballast as required in the turnout, crossover, or double point split switch derail and raise to proper grade in a minimum of two (2) lifts. The initial lifts shall not exceed four (4) inches. The final lift shall not exceed two (2) inches and all tracks shall be brought into final alignment at that time. In addition, stabilize with a dynamic track stabilizer. Surfacing (tamping), ballast dressing requirements, alignment tolerances, and de-stressing shall be in accordance with Section 20400, Track Construction.

1. Use care not to surface through frog utilizing the tampers switch hooks only. Wing rail or frog base plates can be bent or torn and rendered inoperable. Use helper jacks on opposite guard rail and frog itself to lift track and achieve proper surface if tie tamper is not equipped with lifting arm for the outer rail.

2. Use care when surfacing through switch point section so that rail remains properly seated in slide plates be careful not to allow tamping tools to strike or damage turnout component.

G. After the turnout, crossover, or double point split switch derail and associated track has been completely surfaced, lined, stabilized, and dressed with ballast, place walkway aggregate around the turnout and associated track to the dimensions governed by CPUC General Order 118 and as shown on the Contract Drawings and specified in Section 20110, Ballast and Walkway Aggregate, and Section 20400, Track Construction.

H. Install switch stands and adjust the switch operating mechanisms so that the switch operates smoothly and without requiring excessive forces. Force at end of handle must be verified with a torque wrench designed for testing switch stand resistance. The measured force at end of handle shall not exceed 30 pounds for the lift-up handle position, 50 pounds for the middle handle position, or 75 pounds for the push-down position. Hand throw switch stands shall have a proper target. Lubricate switch plates and connection points in the switch rod with the lubricants specified herein.

I. Install switch to hold the switch point tightly against the stock rail when stand is in normal position. Adjust switch rods to hold the opposite point tightly against the rail when stand is in reverse position. Secure switch stands with spikes or screw spike fasteners to the headblock as required. Square headblocks with the track prior to tamping.

J. Install and adjust as required all rods and plates, including switch point rods, switch point rollers, switch stand rods, basket rods, gauge plates, steel tie straps and U5 box and connections.

K. Install signal bonding as required in accordance with Section 18400, Rail Bonding. Coordinate special trackwork installation with signal work.

L. After installation of special trackwork, perform necessary tests to ensure the operating signal system has been restored. Complete all signal testing in accordance with Section 18600, Signal Systems Testing, prior to placing the turnout in service. Obtain approval of signal test results from the Engineer prior to opening the track to service.

M. Refer to Section 01011, Work Planning, for track back in service requirements. Complete the Return to Service Report in Section 20400, Track Construction, prior to restoring track to service.

3.03 PANELIZED TURNOUT, CROSSOVER AND DOUBLE POINT SPLIT SWITCH DERAIL CONSTRUCTION

A. As an option, construct panelized turnout, crossover, and double point split switch derail as a unit or in multiple panels for installation into the track.

B. Submit the drawing for panel construction for approval. The proposed design shall not result in additional field welds within the turnout than as shown in the standards drawings.

C. Provide all equipment, tools and materials necessary to safely move the panelized turnout, crossover or double point split switch derail as a unit or in multiple panels, providing sufficient bearing to avoid excessive stress to the turnout, crossover or double point split switch derail during handling. Repair any damage caused to turnout, crossover, or double point split switch derail during handling and installation to a condition in accordance with this Section and Section 20400, Track Construction.

D. Panelized turnout construction tolerances shall conform to the track criteria and tolerances in Section 20400, Track Construction.

3.04 DERAIL SIGNS

A. Install derail sign and post in conformance with Caltrain Standard Drawings.

3.05 FIELD QUALITY CONTROL

A. After completion of special trackwork installation, perform inspection of the track alignment as to line, grade, and cross section.

1. Correct track alignment and profile with errors exceeding construction tolerances specified in Section 20400 Track Construction.

2. Prepare an as-built report with tabulation of the vertical and horizontal positions of the final track alignment.

3. Final acceptance will not be granted until work, punch list, and as-built data of final alignment, test results, and all required forms are submitted and verified.

END OF SECTION

SECTION 20600
CONCRETE GRADE CROSSINGS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes specification for furnishing and installing concrete grade crossing panels.

1.02 REFERENCE STANDARDS

A. Caltrain Standard Drawings

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

1. Manual for Railway Engineering

1.03 SUBMITTALS

A. Submit crossing panel system shop drawings.

B. Submit list of all crossing panel system materials.

C. Submit installation instructions.

D. Qualifications: Submit documentation for Engineer's approval that manufacturer has satisfactorily furnished grade crossing panels and complies with qualification requirements specified herein.

E. Submit documentation for Engineer's approval that tie manufacturer has satisfactorily furnished concrete ties for the specified concrete panels and meets the requirements of Section 20140.

1.04 QUALITY ASSURANCE

A. Qualifications: The concrete panel manufacturer and concrete tie manufacturer have furnished concrete crossing panels and concrete ties as a system to Class 1 Freight or Commuter Railroads for use on 10 feet long concrete ties within the 5 year requirement in Section 20140.

PART 2 – PRODUCTS

2.01 CONCRETE GRADE CROSSING SYSTEM

A. Grade crossing system shall be designed for the specified rail and tie type, size, and dimensions. System shall be complete with all components, including 10 foot long precast concrete crossing panels, rubber seat pads for gage and field panels, assemblies, rubber flangeway inserts, fasteners, metal panel end deflectors and end restraints in accordance with Caltrain Standard Drawings.

B. The panels shall be shunt resistant. Designed with panel lifting eye hooks for lifting panels, provide one set of lifting hooks and cables for the specific panels.

C. Furnish panels with permanent mark on each panel top, imprinted in the concrete during fabrication, indicating the size of rail, weight of panel, manufacturer's name, and month/day/year of manufacture. Additionally, mark ends of panels with paint indicating size of rail and weight of panel.

D. Materials:

1. Rebar: ASTM Grade 60

2. Steel Angle: ASTM Grade 36

E. Concrete compressive strength shall be minimum 6000 psi.

2.02 CONCRETE CROSSTIES

A. The grade crossing panels shall be compatible with the 10 feet long grade crossing concrete ties. The concrete crossties shall be new 10 feet long flat-top crossties conforming to the requirements in Section 20140, Concrete Crossties and Rail Fastener Assemblies. The concrete crossties and concrete panels shall fit properly together and the ties shall provide a stable load bearing surface.

B. See Caltrain Standard Drawing SD-2212 for rail fastener requirements.

2.03 TIMBER CROSSTIES

A. Timber crossties for concrete grade crossings shall be new 7 by 9 inch by 10 feet 0 inch long. Timber ties shall conform to the requirements in Section 20130, Timber Crossties and Switch Ties.

B. Fasteners for timber ties under the concrete grade crossings: Two 16-inch Pandrol plates, four (4) galvanized Pandrol E-2055 clips, and eight 15/16 inch by 6 1/2 inch long screw spikes.

2.04 OTHER TRACK MATERIALS

A. Except where otherwise required by panel manufacturer, other track materials used in connection with installation of grade crossings shall be as specified in Section 20120, Track Appurtenances and Other Track Material.

B. Rubber inserts or fillers for the grade crossing panels shall be manufactured from 100 percent extruded virgin rubber (virgin SBR – Styrene Butadiene Rubber) and shall meet the following requirements:

1. Rubber filler shall fit the specified rail sections. See Caltrain Standard Drawings for dimensions.

2. Rubber filler shall have connector pins at the joints or secured to the track panels to prevent gaps and maintaining continuity throughout the railroad crossing.

3. Rubber filler shall fit snugly against the top of rail without gaps.

4. Material properties:

   a. Tensile: 850 psi

   b. Elongation: 400%

   c. Hardness: 65 ± 5 Durometer Shore A

2.05 SOURCE QUALITY CONTROL

A. If the crossing panel manufacturer is different from the tie manufacturer, panel manufacturer shall assemble one complete 10 foot grade crossing panel prototype along with six crossties at the panel manufacturer's plant to demonstrate the compatibility of the two products. Both the panels and the crossties shall fit together properly and provide a stable load bearing surface.

   1. Notify the Engineer sufficiently in advance of prototype assembly to give the Engineer the opportunity to observe the demonstration.

PART 3 – EXECUTION

3.01 DEMOLITION

A. Remove any existing pavement, track structure, ballast, natural ground and other materials down to the elevations shown in the Contract Drawings and as specified in Sections 02100, Demolition, and 02300, Earthwork.

3.02 TRACKBED PREPARATION

A. Excavate existing ballast and other existing base in accordance with Caltrain Standard Drawings and the Contract Drawings.

B. Construct the trackbed, including aggregate base and HMAC underlayment in accordance with Caltrain Standard Drawings and the Contract Drawings.

C. Install surface ditches and other drainage facilities, including track subdrains, as shown on the Contract Drawings. Clean all existing drainage ditches and channels adjacent to the grade crossing and slope to provide drainage away from the grade crossing.

3.03 TRACK CONSTRUCTION

A. Construct track at grade crossings as specified in Section 20400, Track Construction, and related sections, as modified and appended in this Section. No field welds of rail are allowed within 25 feet of the limits of the new grade crossing.

B. Within the limits of the crossing, the gage of the track shall be 56-1/2 inches, plus or minus 1/16 inch.

C. Within the limits of crossing on concrete crossties, place ties at 24-inch spacing. Place transition ties on each end of the crossing as shown on the Caltrain Standard Drawings.

D. Within the limits of crossings on timber crossties, place ties in accordance with the requirements of the Engineer approved concrete panel manufacturer. Place the transition ties on each end of the crossing as shown on the Caltrain Standard Drawings.

E. On wood tie track with cut spikes and anchors, fully box anchor all ties for 195 feet on each side of the grade crossing limits and beyond the transition ties.

F. Final align and surface the track in accordance with the requirements in Section 20400, Track Construction, prior to placement of crossing panels.

3.04 EXAMINATION AND APPROVAL

A. Prior to installation of crossing panels, perform inspection on track final profile, all fastenings of the rail to the ties, and grading.

B. Notify the Engineer prior to installing panels for inspection and approval of the track surface and alignment. Obtain Engineer's approval prior to installation.

3.05 INSTALLATION OF CROSSING SYSTEM

A. Be familiar with the type of installation to be performed and install the grade crossing system in accordance with panel manufacturer's installation instructions.

B. Do not to drop or strike the panels.

C. Remove deleterious materials from the top of the ties prior to installation of the concrete panels and ensure that the panels are seated with good bearing on the ties. Crossing panels shall not "rock" on the crossties once in final position.

D. Rubber flangeway shall be attached to the concrete crossing panels as a unit and shall fit snugly to the web of the rail in accordance with Caltrain Standard drawings.

E. The crossing components shall fit snugly and have a uniform surface without sharp edges resulting from elevation change between adjacent panels, the panels and the rail, the panels and flangeway inserts, the rail and flangeway inserts, or any other combination of crossing surface components. Crossing surface that has significant elevation breaks greater than 1/4 inch between adjoining components is not acceptable.

F. Weld crossing panels together with a minimum of six 8-inch to 10-inch beads at time of installation, in accordance with Caltrain Standard Drawings. Finished grade crossings shall match grade crossing approach pavement.

G. Install end restraints and metal deflectors on each end of the crossing in accordance with Caltrain Standard Drawings. Tack-weld deflectors and end restraints to the ends of the panels. Fasten end restraints to timber ties with screw spikes.

H. Refer to Section 02720, Asphalt Paving. Place asphalt pavement at the ends of crossing panels as indicated on Caltrain Standard Drawings and the Contract Drawings.

I. Fill eye hooks for lifting panels with manufacturer's recommended epoxy or grout per Caltrain Standard SD-2153. Final surface shall be smooth and flush with the panels.

J. Provide the necessary signal support. All associated signal tests shall be completed, and the results accepted by the Engineer prior to placing the grade crossing in service.

K. Complete paving work at crossing approaches and related drainage, sidewalk, and other work as indicated on the Contract Documents.

3.06 REPAIR OR REPLACEMENT

A. Repair or replace any damage to the concrete panels, flangeway inserts, or other components resulting from handling and installation.

3.07 FIELD QUALITY CONTROL

A. At completion of work, prior to returning grade crossing to service, perform a road test with cars and trucks passing newly installed grade crossing panels at the speed limit to demonstrate the quality of smooth ride on the road and that concrete panels are free of "rocking" action on the crossties.

B. Submit reports, completed forms, and documentation of signal testing, rail, destressing, welding, and test results.

C. Perform any other tests required by the jurisdictional authority of the roadway.

END OF SECTION

SECTION 20710
FLASH BUTT RAIL WELDING

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section includes specification for welding rails together to Continuous Welded Rail (CWR) strings by the electric flash butt weld process. Rail within turnouts or elsewhere as approved by the Engineer may be thermite field welds in accordance with Section 20720, Thermite Rail Welding.

B. Refer to Sections 20400, Track Construction; 20150, Rail, and 20720, Thermite Rail Welding, for additional requirements.

1.02 REFERENCE STANDARDS

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

1. Manual for Railway Engineering, Volume 1, Chapter 4, Rail

B. ASTM International (ASTM):

1. E10 Standard Test Method for Brinell Hardness of Metallic Materials

2. E94 Standard Guide for Radiographic Examination Using Industrial Radiographic Film

3. E164 Standard Practice for Contact Ultrasonic Testing of Weldments

4. E709 Standard Guide for Magnetic Particle Testing

C. Federal Railroad Administration (FRA) Code of Federal Regulations (CFR), Title 49, Subtitle B, Chapter 2:

1. Part 213 Track Safety Standards

2. Part 214, Subpart D On-Track Roadway Maintenance Machines and Hi-Rail Vehicles

1.03 SUBMITTALS

A. Submit the following welding equipment and procedures to the Engineer for approval:

1. Work program and schedules for electric flash butt rail welding.

2. Working and laying out drawings, manufacturer's catalog, performance data and detailed specifications of the equipment to be used for rail welding and handling. Include lists and details of equipment or welding plant for the electric flash butt welds.

3. Welding procedure qualification.

4. Written description of welding ability, including facilities, personnel qualifications and a list of completed projects similar in scope.

5. Procedures for pulling and aligning the rail, allowances for destressing, and procedures for bolt holes.

6. Details of proposed equipment and procedure proposed for straightening welds, if required, including reference data of successful use on previous projects.

7. Proposed facility for storing CWR.

B. Submit detailed description of testing program and procedures to be performed by Inspection and Testing Agency (ITA). Submit a copy of the agreement between the Contractor and ITA at least 30 days before initiating welding operations. Refer to Section 01400, Quality Control and Assurance, for submittal of proposed ITA.

C. Submit the following reports:

1. Brush recorder charts for each electric-flash butt weld.

3. Daily summary reports of production rail welding inspection and testing.

3. Summary CWR strings.

4. Record on each CWR string welded in track.

1.04 QUALITY ASSURANCE

A. The agreement between Contractor and ITA shall specify the following:

1. ITA shall submit personnel qualifications and training, equipment maintenance and calibration frequency, weld recording and numbering, testing results, daily production deliverables, rail pre-weld inspection and preparation directly to the Engineer.

2. ITA shall promptly provide copies of all correspondence between ITA and the Contractor to the Engineer.

3. The agreement shall run for the duration of the Contract, except as otherwise agreed to by the Engineer.

4. Test reports to the Engineer to allow for 7 days review and appropriate action by the Engineer prior to being eligible for payment.

5. Rail shall be inspected prior to welding, do not mix head harden with standard strength rails. All track bolt holes, signal cable fouling wire bonds, or drilled holes shall be cut out and removed.

6. Provide daily production reports, the recorder computer printouts or electronic data for all complete welds, test results, in addition to visual inspection and measurements on head, web, and base alignment of all welds. Rejected flash-butt welds shall be cut out and re-welded.

B. Regulatory Requirements: Perform work in accordance with CFR 49 Part 213.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Weld Owner-furnished or Contractor-furnished rail strings into CWR in accordance with this Section.

B. Provide all incidental materials required to complete the work of this Section.

PART 3 – EXECUTION

3.01 RAIL STORAGE AND HANDLING

A. Equipment and methods to handle and store CWR strings shall conform to the requirements of AREMA Manual, Chapter 5, Section 5.2.3, "Handling and Transporting Continuous Welded Rail (CWR)."

B. Do not use any methods that are likely to cause scratching, notching, rubbing, scoring, or striking of the rails.

C. Support CWR strings off the ground and space them such that the load on the supporting ground will not exceed 1,500 pounds per square foot.

D. Store CWR at locations shown on the Contract Drawings or where designated by the Engineer.

3.02 RAIL WELDING

A. Weld rail by the electric-flash butt welding process. Welding shall conform to AREMA Manual, Chapter 4, Section 3.11, Specifications for Fabrication of Continuous Welded Rail, as applicable, except as modified or appended in this Section. All production welding shall use procedures specified in this Section.

B. Each welding machine shall be equipped with a brush recorder to produce charts showing traces of electrical impulses and movable platen travel. Submit chart to the Engineer for each weld. If the chart indicates performance which is not in conformance with the approved standards, the weld will be rejected.

C. Refer to Section 01590, Temporary Facilities. Furnish all mobile electric power and utilities required.

D. CWR Strings:

1. String lengths of CWR shall be in 1,660 feet lengths, or length required to install special trackwork or approaches to fixed crossings or structures, or other lengths as approved by the Engineer.

2. Paint string number and length with an aluminum paint on both sides of the web of the rail at each end of each string.

3. Weld rails so that Heat Number appears on the same side in each string.

4. Do not weld within 8 inches from a bolt hole.

5. Do not mix and weld head harden rail with standard strength rail.

E. Rail Straightening and Cutting Back:

1. Field align or cut back rail ends not meeting the requirements of AREMA: Chapter 4, Section 3.11, Specifications for Fabrication of CWR.

2. When rail ends cannot be straightened or cut back to achieve the required rail end tolerance, rail will be rejected.

3. Mark rejected rail and stockpile in an on-site area designated by the Engineer.

F. Cutting and Cropping of Rail:

1. Cut clean and square all rails cut prior to welding by means of rail saws or abrasive cutting disks in accordance with AREMA Manual, Chapter 4, Section 2.1, Specifications for Steel Rails. Do not torch cut rail.

2. Crop or cut rails with bolt holes or thermite welds within 2 feet of a weld at least 8 inches behind the bolt hole or thermite weld. If the rail is bent, cut back the rail an additional amount to remove the bend.

3. The small, scrap sections of cropped rail shall become the property of the Contractor and shall be disposed of off-site.

4. After cutting back the rail, slide back the next rail to make ready for the next weld or joint.

5. Close gaps generated during sliding back the next rail by installing a plug of owner-furnished rail.

6. Plugs used to fill the gaps shall be at least 15 feet in length on tangent and 30 feet in length on curved track. Similarly, no rail left in track shall deviate from this requirement.

7. Prior to placing track back into service at the end of each shift, fully spike, bolt, and anchor the rail according to the requirements in FRA Class 4 track.

G. Rail End Preparation:

1. Clean the rails free of grease, oil, dirt, scale and moisture to a minimum of 6 inches back from the rail ends, including the rail end surfaces.

2. Grind rail areas in contact with electrodes to remove mill scale and raised lettering.

3. Align the faces of the rail ends. Divide any difference in the width of the rail heads equally on both sides of the head.

4. Align vertically for a flat running surface. Any difference of height of the rail shall be made in the base.

5. Align horizontally so that any variance in width of the 2 rail heads is split equally between gauge and field side, providing the misalignment along the gauge line does not exceed 0.040 inch. Additional variance shall be apportioned to the field side of the weld.

6. Rail ends shall be square and smooth, and shall show no steel defects, dents or porosity before welding.

H. Conform to the requirements of Section 20400, Track Construction for adjusting and destressing rail.

3.03 WELD QUALITY

A. Each weld shall have full penetration and complete fusion and shall be free of cracks.

B. Small porosity and slag inclusion which show on radiographic film will be accepted if the total area of internal defects does not exceed 0.09 square inch and the largest single defect does not exceed 0.180 inch in diameter.

3.04 WELDING PROCEDURE QUALIFICATIONS

A. Prior to beginning of production welding, make three (3) test welds on each welding machine using the same welding procedure that will be used in production welding. Each test weld shall join two (2) pieces of rail 18 inches in length.

B. Inspection of welding procedures and testing of welds shall be performed by the ITA employed by the Contractor.

C. Test each test weld radiographically with a minimum of 4 exposures: One through the head, one through the web, and one through each of the 2 flanges. Perform radiography in accordance with ASTM E142. Radiographic film shall be Type 1 or Type 2. Exposed film density shall be within the range of 1.5 to 3.8.

D. Magnetic particle test each test weld by the coil method (longitudinal magnetization) using the dry powder method in accordance with ASTM E709.

E. Ultrasonically test each test weld in accordance with ASTM E164. Use equipment capable of detecting a 3/64-inch discontinuity, 6-1/2 inches below top of rail.

F. Test each test weld for hardness in accordance with ASTM E10. Perform this test on the head of the rail in the center of the weld. The hardness of the weld shall be equal to the average Brinell hardness of the two (2) parent rails joined with a permissible variance of 20 Brinell points.

G. Acceptance will be based on the weld quality requirements stated above.

3.05 WELD NUMBERING

A. Mark a sequential weld number on the rail immediately adjacent to the weld using a quality aluminum paint marker at the time the weld is made.

B. Number welds sequentially in the order in which they are made.

C. Obtain the initial weld number from the Engineer.

D. When defective welds are replaced, assign a new sequential number to the new weld by adding a letter to the defective weld number. (e.g. defective weld 109 will be replaced by 109A)

3.06 FINISHING THE WELDS

A. Finish weld with a rail mounted profile grinder specifically designed for the work. Finishing shall conform to the following tolerances:

1. Top of rail head: Plus 0.010 inch to minus 0 inch of the parent rail section.

2. Sides of rail head: Plus or minus 0.010 inch of parent rail section.

B. Finish the balance of the rail section with a hand-held grinder as required to remove notches, protrusions, gouges, visible cracks and other defects. All grinding shall blend to the parent rail section and shall not overheat the steel. Complete heavy grinding while the steel is still hot from welding.

3.07 INSPECTION AND TESTING OF PLANT WELDING

A. The ITA shall perform and report all inspection and testing of production welding as specified herein within 24 hours of making the welds. Keep the Engineer informed regarding testing of production welds so that the Engineer may observe inspection and testing.

B. Visually and dimensionally inspect each weld to determine conformance with the alignment and finishing tolerances in AREMA Manual, Chapter 4, Section 3.11, Specifications for Fabrication of Continuous Welded Rail. Cut out and re-weld out-of-tolerance welds in accordance with this Section.

C. ITA shall magnetic particle test each weld by the coil method (longitudinal magnetization) using the dry powder method in accordance with ASTM E709. Cut out and re-weld welds giving fault indications in accordance with this Section.

D. Ultrasonically test each weld for defects in accordance with ASTM E164. Use testing equipment capable of detecting a 3/64-inch discontinuity, 6-1/2 inches below top of rail. Perform ultrasonic testing after rail has been destressed.

E. Inspect each weld using a 3-foot straightedge along the centerline of the rail and 0.625 inch below top of rail on the gauge side of the rail head. Center the straightedge over the weld; the gap between the straightedge and the rail shall comply with the requirements of AREMA Manual, Chapter 4.

F. Submit to the Engineer a daily summary of results of all testing for each weld on a form containing the following information:

1. Date and shift

2. Inspector's and welding foreman's name

3. Weld number

4. Result of magnetic particle test

5. Result of ultrasonic test

6. Note of any dimensional tolerance or other rejections

7. Certification of acceptance or rejection of weld

G. Submit a summary of CWR strings produced, including the following information:

1. String number

2. Lead Rail heat, ingot and letter

3. End Rail heat, ingot and letter

4. String length

5. String temperature at the time of measurement of length

H. For every rail string installed, record on a form provided in this Section the unique string number assigned to the string, the rail manufacturer of each individual segment of rail that makes up the string, the month and year date that each individual segment of rail was rolled, the length of each individual segment of rail that makes up the string, and the location of each numbered weld that connects each individual segment of rail in the entire string (i.e. Begin String 145, CF&I 04/96 33', Weld 1, PST 10/91 30', Weld 2 etc….End String 145). The form shall also indicate the stationing where the "Begin String" portion of the string is installed and the stationing of where the "End String" portion of the string is installed, the track number, east/west rail it was installed on (i.e. Being String 145 Sta 1000+10, End String 1010+00, MT-1, east rail).

3.08 REPAIR OF DEFECTIVE WELDS

A. Cut out and re-weld all welds rejected during inspection or testing.

B. Crop rails 6 inches from the center of the defective weld prior to rewelding.

3.09 FIELD QUALITY CONTROL

A. The Engineer may randomly select any welds and request to be retested at any time within the period of the Contract. Replace any defective welds.

B. Prior to completion of welding operation, visually inspect all welds to verify the base riser break off area has been smoothed. Smooth areas which have not been smoothed.

3.10 CLEAN UP

A. Inspect areas where welding operation performed. Collect and dispose any remaining scrap sections of cropped rail daily after completion of welding operation.

END OF SECTION

SECTION 20720
THERMITE RAIL WELDING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes specifications for welding rails together by the Thermite process at the project site for the purpose of joining rail strings and for other in-track welds.

B. Refer to Section 20400, Track Construction; Section 20150, Rail, and Section 20710, Flash Butt Rail Welding, for additional requirements for thermite welds.

1.02 REFERENCE STANDARDS

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

1. Manual for Railway Engineering, Volume 1, Chapter 4, Rail

B. ASTM International (ASTM):

1. E164 Standard Practice for Contact Ultrasonic Testing of Weldments

2. E709 Standard Guide for Magnetic Particle Testing

C. Federal Railroad Administration (FRA) Code of Federal Regulations (CFR), Title 49, Subtitle B, Chapter 2:

1. Part 213 Track Safety Standards

D. Caltrain Standards and CWR Plan

1.03 SUBMITTALS

A. Submit detailed procedure specification of the step-by-step methods to be employed in making the welds for Engineer's approval. Include complete description of each of the following items, as applicable to the weld and manufacturer being provided:

1. Manufacturer's trade name for the welding process.

2. Method used for cutting and cleaning the rail ends. Refer to Section 20400, Track Construction, for allowable means of cutting rail.

3. Minimum and maximum allowable gap between rail ends prior to welding.

4. Methods used for cleaning multiple-use crucibles and removing moisture, and the procedures for tracking the number of welds made. If single-use crucibles are used, the above-mentioned procedure will not be required.

5. Method used for preheating, including time and temperature.

6. Method used for removing the upset metal and finishing the weld to the final contour, including a description of special tools and equipment.

7. Quality control procedures to be followed.

8. Welders training, qualifications and certification, understanding and knowledge of Caltrain CWR Plan, Caltrain and FRA Standards.

B. Submit welder qualifications and certification from weld-kit manufacturer for Engineer's approval.

1.04 DELIVERABLES

A. Prepare welding testing record in a form acceptable to the Engineer. Submit signed original form to the Engineer within 14 days of completion of the weld testing.

B. Submit a completed weld record for each weld with the required information, such as weld number, rail location, rail manufacturing details, rail temperature, date, time of weld, in addition to any other forms and information required at time of destressing during welding operations. Submit information as required on the forms provided by the Engineer within 72 hours of completing the weld.

1.05 QUALITY ASSURANCE

A. Perform welding under the direct supervision of an experienced welding supervisor or foreman. Welding supervisors and foremen shall be qualified and familiar with FRA parts 213.119, 213.305, 213.341, 213.343, and Caltrain CWR Plan.

B. Welders shall be certified by weld kit manufacturer

C. Verify that weld kits have not expired.

D. Test weld prior to allowing revenue train traffic over weld.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Handle weld kits with care from receipt to installation to ensure high quality welds.

B. Identify weld kits by brand name in the original Manufacturer's container. Store weld kits in a moisture-proof container.

C. Use weld kits prior to the expiration date. Remove expired weld kits from Owner's property.

PART 2 - PRODUCTS

2.01 RAIL WELDING KITS

A. The following rail welding kits are approved.

1. Calorite,by Pandrol Industries, Inc.

2. Boutet, by Railtech.

3. Orgo-Thermit, by Orgo-Thermit, Inc.

PART 3 - EXECUTION

3.01 GENERAL

A. Perform welding in accordance with the requirements of the AREMA Manual, Chapter 4, Section 3.13, Specification for the Quality Assurance of Thermite Welding of Rail and Section 3.11, Specifications for Fabrication of Continuous Welded Rail, except as modified or amended by this Section.

B. Welding of secondhand rail for other than main line tracks according to the requirements of the AREMA Manual, Chapter 4, Section 3.12, Inspection and Classification of Secondhand Rail for Welding, for Class 1 Rail.

C. Position weld in the crib between two ties. Do not place weld on a tie. Field welds are not permitted in road crossings.

D. Weld compromise joints using in track thermite welds for compromise joints.

E. Do not weld in rain, or other inclement weather.

3.02 END PREPARATION

A. Clean the rails to be welded of grease, oil, dirt, loose scale, and moisture to a minimum of 6 inches back from the rail ends, including the railhead surface. Use a wire brush to completely remove dirt and loose oxide, and use oxygen-acetylene torch to remove grease, oil and moisture.

B. Align the rail ends using a rail beam specifically designed for this purpose or a 36-inch straight edge.

C. Use a power grinder with an abrasive wheel to remove scale, rust, burrs, lipped metal and mill brands which would interfere with the fit of the mold for two (2) inches on each side of the ends. Rail ends shall show no steel defects, dents, or porosity before welding.

D. Cut rail square using approved rail saws.

E. Field welds shall be no closer than 8 inches from any existing bolt hole.

3.03 GAP

A. The minimum and maximum spacing between rail ends shall be as specified by the rail welding kit manufacturer and the approved procedure specification. Wide gap welds will not be permitted.

3.04 ALIGNMENT

A. Properly gap and align the ends of the rails to be welded to produce a weld which shall conform to the alignment tolerances below. Hold the rail gap and alignment without change during the complete welding cycle.

1. Alignment of rail shall be done on the head, web, and base of the rail.

2. Vertical alignment shall provide for a flat running surface. Any difference of height of the rails shall be in the base.

3. Horizontal alignment shall be done in such a manner that any difference in the width of heads of rails shall occur on the field side.

4. Maximum horizontal offsets: 1/25 inches in the head and/or 1/8 inches in the base.

5. Surface Misalignment Tolerances:

   a. Maximum combined vertical offset and crown camber: 1/25 inches per foot at 600 degrees F.

   b. Maximum combined vertical offset and dip camber: 1/10 inches per foot at 600 degrees F.

6. Gage Misalignment Tolerance: Maximum combined horizontal offset and horizontal kink camber is 1/25 inches per foot at 600 degrees F.

3.05 THERMITE WELD PREHEATING

A. Preheat the rail ends prior to welding to the temperature and for the time specified in the approved welding procedure specification to ensure full fusion of the weld metal to the rail ends without cracking of the rail or weld. Engineer will reject welds that were made without the rail first properly preheated in accordance with the manufacturer's recommendations.

3.06 THERMITE WELD COOLING

A. Leave the molds in place, after tapping for a sufficient time to permit complete solidification of the molten metal, in order to allow proper slow cooling in order to prevent cracking and to provide a complete weld with proper hardness and ductility.

3.07 WELD FINISHING AND TOLERANCES

A. Bring welded joints in the finished track to a true surface and align by means of an approved grinding or planning machine (shear). Use a hand grinder for the

final smoothing and for areas not accessible to a track grinder. Perform finish grinding with an approved grinder operated by a skilled workman. Take care to grind evenly and leave the joints in a satisfactory condition. Finishing shall eliminate all cracks. Complete the completed weld by mechanically controlled grinding in conformance with the following requirements:

1. Tolerances: A finishing deviation of not more than plus or minus 1/100 inches of parent section of the rail will be allowed.

2. Welds produced by welding kits which are specially designed to produce reinforced welds need not be ground in the fishing area except as necessary to remove fins, burrs, cracks, etc.

3.08 WELD QUALITY

A. Each completed weld shall have full penetration and complete fusion and be entirely free of cracks or fissures.

3.09 WELD NUMBERING

A. Semi-permanently mark a sequential weld number, rail temperature, and date on the rail immediately adjacent to the weld using a quality paint marker at the time the weld is made.

B. Number the welds sequentially in the order in which they are made.

C. Obtain the initial weld number from the Engineer.

D. When defective welds are replaced, assign a new sequential number by adding a letter to the defective weld number (e.g. defective weld 109 would be replaced by 109A).

3.10 FIELD QUALITY CONTROL AND TESTING

A. Visually inspect all welds at the time of welding and during the grinding operation.

B. Prior to completion of welding operation, visually inspect all welds to verify the base riser break off area has been smoothed.

C. Visually inspect and check welds in accordance with approved procedures to ensure there are no surface defects such as cracks and to verify that the welds conform to the alignment and finishing tolerances specified in this Section.

D. Each completed field weld shall be marked with the date, name of welder, air temperature, and rail temperature or with date, name, and "free weld" for welds not used to control CWR thermal adjustment.

E. Verify that each completed weld has full penetration and complete fusion and is entirely free of cracks or fissures.

F. Perform the following tests on all welds. All testing shall be performed by a qualified Independent Testing Agency (ITA) hired by the Contractor. Refer to

Section 01400, Quality Control and Assurance. The testing agency shall provide test results directly to the Engineer.

1. Ultrasonic testing shall be performed after the weld has been ground and finished to specified tolerances. Ultrasonic testing shall be performed in accordance with ASTM E164. Equipment used shall be capable of detecting a 3/64-inch discontinuity, 6-1/2 inches below the top of rail.

2. Magnetic particle test each weld by the coil method (longitudinal magnetization) using the dry powder method in accordance with ASTM E709. Cut out and re-weld welds giving fault indications in accordance with this Section.

G. The weld quality, finishing and alignment requirements specified in this Section shall also apply as requirements of acceptance.

H. Perform testing of welds in active tracks prior to revenue service. Perform testing of welds in other tracks prior to placing the track in service. Replace unacceptable welds in accordance the requirements of this Section.

I. The Engineer may randomly select any welds to be retested at any time within the period of the Contract. Such testing shall be performed by Contractor-hired ITA.

3.11 REPLACEMENT OF DEFECTIVE WELDS

A. Welds made outside of the track which the Engineer determines to be unacceptable prior to rail installation shall be cut out, rails pulled together to the indicated rail gap, and re-welded.

B. Cut unacceptable welds and replace with a section of rail and 2 new welds. The minimum length of the new rail used shall be 15 feet.

C. Saw cuts shall be made at least 6 inches from the centerline of the faulty weld. In-track welds shall be made in accordance with the requirements specified in this Section.

D. Test the replacement welds as specified in this Section.

E. Install joint bars on defective welds in active track immediately upon completion of testing, and under no circumstances later than 8 hours after testing in accordance with Section 20120, Track Appurtenances and Other Track Material, and comply with FRA Standards Part 213.

3.12 CLEAN UP

A. Inspect areas where welding operation performed. Collect and dispose any remaining scrap sections of cropped rail daily after completion of welding operation.

ATTACHMENT FOLLOWS

ATTACHMENT 20720
RECORD OFWELD

INSTALLATION _____ WELDER'S NAME _____ WELD NUMBER _____

FINAL INSTALLED LOCATION _____TRACK _____RAIL WEIGHT_____ RAILROAD STATIONING_____ RAIL L. R. (Circle) FACING UPSTATION

DATE _____ TIME _____ AM PM (Circle) COMPLETE WELD (YES/NO) circle one

AIR TEMPERATURE _____ ^{O}F. WEATHER _____

RAIL TEMPERATURE _____^{O}F. PRE-HEAT TIME _____

WELD KIT MANUFACTURER _____ WELD INGOT #

RAIL GAP (NEAREST 1/16 INCH) _____ RAIL CUT REQUIRED? YES NO (Circle)

BACK RAIL

MANUFACTURER _____ RELAY RAIL? YES NO (Circle)

YEAR/MONTH ROLLED _____ HEAT NUMBER

AHEAD RAIL

MANUFACTURER _____ RELAY RAIL? YES NO (Circle)

YEAR/MONTH ROLLED _____ HEAT NUMBER _____

REMARKS _____

_____

_____

ULTRASONIC TEST DATE AND RESULTS

KIT MFG. REPRESENTATIVE PRESENT _____ (Initial) WELDING FOREMAN _____ (Signed)

PCJPB'S

REPRESENTATIVE PRESENT _____ (Initial) RECORDER _____ (Signed)

END OF ATTACHMENT

END OF SECTION