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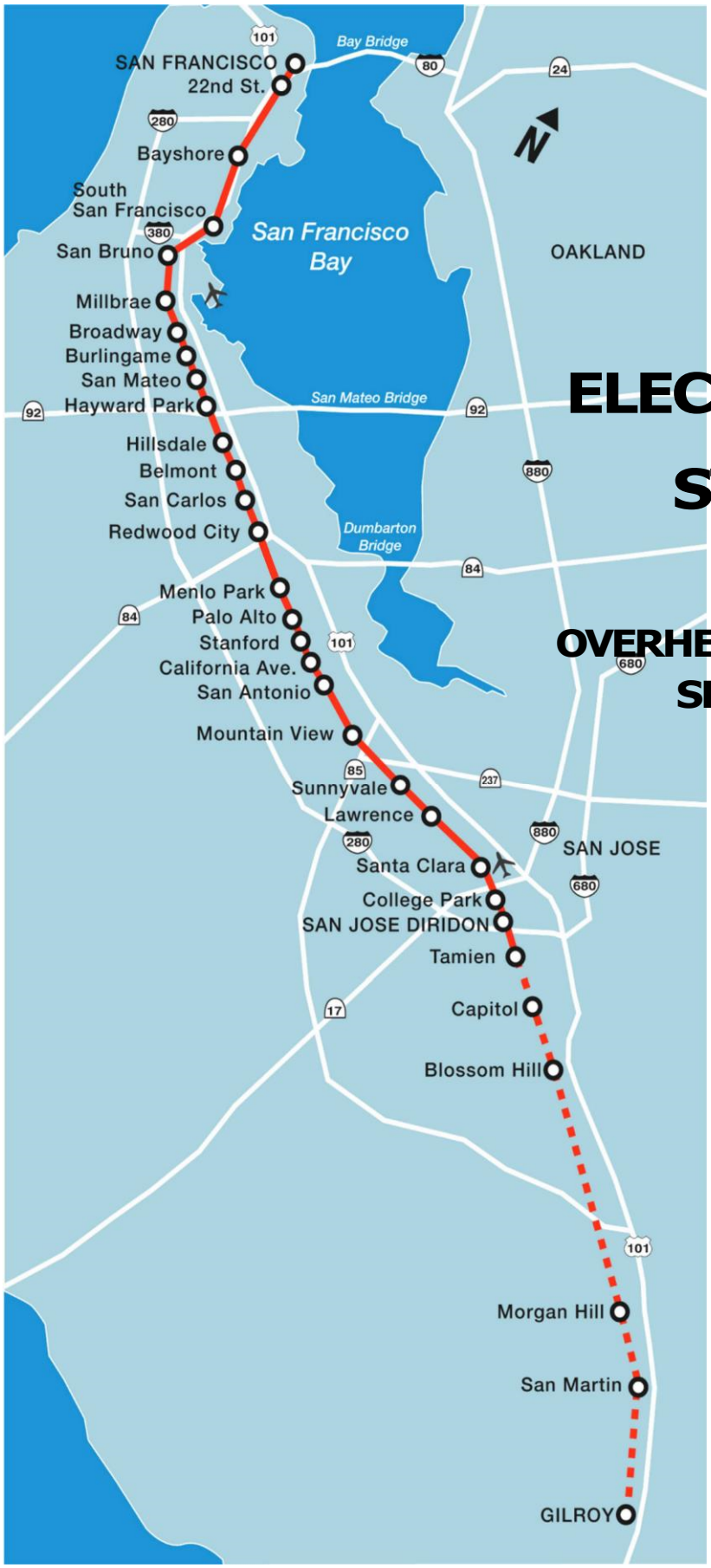


ELECTRIFICATION STANDARD

OVERHEAD CONTACT SYSTEM SPECIFICATIONS

JANUARY 01, 2024
EDITION

SECTION 00 01 10

TABLE OF CONTENTS

SECTION	TITLE
03 11 00	Concrete Forming
03 15 00	Concrete Accessories
03 20 00	Concrete Reinforcing
03 30 00	Cast-In-Place Concrete
03 35 00	Concrete Finishing
26 05 26	Systemwide Grounding and Bonding
31 00 00	Earthwork
34 30 03	OCS General Requirements
34 30 06	Interface Requirements
34 30 13	OCS Basic Electrical Materials and Methods
34 30 33	CIDH Foundations
34 30 36	Metal Fabrication for OCS
34 30 39	OCS Metal Poles
34 30 43	OCS Signage
34 30 46	Painting OCS Poles
34 30 49	OCS Grounding and Bonding
34 30 51	OCS Supporting Devices
34 30 53	Galvanized Steel Wire, Wire Rope and Synthetic Strand Rope
34 30 56	Stainless Steel Wire Rope, Strand and Rod
34 30 59	Surge Arresters
34 30 61	Insulators
34 30 63	Section Insulators
34 30 69	Balance Weight Anchor Assembly
34 30 73	OCS Fittings and Hardware
34 30 76	Disconnect Switches for OCS Sectionalization
34 30 79	Uninsulated Conductors and Cables
34 30 80	Insulated Conductors and Cables
34 30 85	OCS Installation
34 30 86	OCS Testing
34 30 89	OCS Special Tools
34 30 93	OCS Manuals and Testing
34 30 96	OCS Spare Parts

SECTION 03 11 00

CONCRETE FORMING

PART 1 – GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for construction and removal of formwork for the placement of cast-in-place concrete.

1.2 REFERENCE STANDARDS

A. American Concrete Institute (ACI):

1. 301, Specifications for Structural Concrete for Buildings
2. 347, Guide to Formwork for Concrete

B. American Plywood Association (APA):

1. PS1-95, U.S. Product Standard for Construction and Industrial 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

1.3 SYSTEM DESCRIPTION

A. The work of this Section shall be performed in accordance with the following provisions:

1. AREMA Manual, Section 1.8, "Forms" of Section 8, "Concrete Structures and Foundations".
2. Caltrans Standard Specifications, Section 51-1.03C: Forms
3. ACI 347: Guide to Formwork for Concrete

1.4 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Samples: Submit form material with submittal of shop drawings, 12 inches by 12 inches or larger in size, for formed concrete which will be exposed in the finished work to the public view.

C. Product Data: Provide manufacturers' data and installation requirements on form materials, form coatings, form ties, and other accessories.

D. Formwork Shop Drawings: Submit drawings that indicate the following:

1. Forming system and method of erection with associated details, including bracing as required ensuring 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 Technical Specifications Section 03 30 00, Cast-In-Place Concrete.

1.5 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

2.1 WOOD FORM MATERIALS

A. Provide form materials if exposed to public view and as required by Contract Documents in accordance with the requirements of APA PS1, 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 High Density Overlay (HDO) Plyform: A-A, 60-60, Class I, EXT-APA trademarked.
3. 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.

2.2 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. Allowable preformed forms include:

1. Preformed Steel Forms.
2. Preformed Fiberglass Forms.

2.3 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 inch in diameter by 1 1/2inches deep or approved equal.

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

3.1 EXAMINATION

A. Verify locations, lines, and levels before proceeding with formwork. Ensure that dimensions agree with shop drawings and correct inconsistencies before proceeding.

3.2 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.

3.3 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, as necessary.

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 accepted 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.

3.4 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.

3.5 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.

3.6 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.

3.7 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 and, 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 properly.

F. After 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 03 35 00, Concrete Finishing. Clean exposed concrete surfaces and adjoining work stained by leakage of concrete.

3.8 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. 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 Caltrain, in which case, patch holes and defects in forms with materials and methods that will not be reflected in the concrete.

3.9 FIELD QUALITY CONTROL

A. Inspect erected formwork 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 approved samples.

D. Check movement using methods, such as plumb lines, tell tales and survey equipment to detect movement of formwork during concrete placement.

END OF SECTION

SECTION 03 15 00

CONCRETE ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for accessories for concrete structures.

1.2 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

1.3 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Submit product data and manufacturer's instructions for elastomeric bearing pads, waterstops, mortar, epoxies, and other items.

1.4 QUALITY ASSURANCE

A. In general, concrete accessories shall be in accordance with the above CSS Sections.

B. Certificates of Compliance: Submit certificates of compliance for joint seals and elastomeric bearing pads.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete Anchorage Devices, Bolts, 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 from Caltrain Standard Specifications, for additional requirements.

C. Waterstops: Conform to the provisions in Caltrans Standard Specifications, Section 51-2.04, Waterstops.

D. Mortar: Conform to the provisions in Caltrans Standard Specifications, Section 51-1.02F, Mortar.

E. Drain Pipe: Conforming to the provisions for pipe for edge drains and edge drain outlets in Caltrans Standard Specifications, Section 68-4, Edge Drains.

F. Embedded Junction Boxes and Conduit: Refer to Section 34 32 66, Underground Ductwork and Structures (under future development).

G. Embedded Drains, Drain Pipes, Reducers, and Fittings: Refer to Section 33 44 00, Storm Drainage System (under future development).

H. Gel-Type Epoxy: Delta AS23-18 A&B gel-type epoxy or approved equal.

I. Epoxy binder: Conforming to the provisions in Caltrans Standard Specifications Section 95-1 and ASTM 881.

J. Low Viscosity Structural Injection Epoxy Binder conforming to Caltrans Standard Specifications Section 95-1.02C and ASTM 881.

2.2 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 Technical Specifications Section 34 32 00 (under future development).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate installation of accessories with Section 03 30 00, Cast-in-Place Concrete, and related concrete sections.

B. Waterstops: Install waterstops as specified in Caltrans Standard Specifications, Section 51-2.04, Waterstops, and waterstop manufacturer's written instruction.

C. 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.

D. Joint Seals: Install joint seals as specified in Caltrans Specifications, Section 51-2.02, Sealed Joints.

END OF SECTION

SECTION 03 20 00

CONCRETE REINFORCING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for concrete reinforcing.

1.2 REFERENCE STANDARDS

A. American Concrete Institute (ACI):

1. 301, Specifications for Structural Concrete for Buildings.
2. 315, Details and Detailing of Concrete Reinforcement.

B. American Society for Testing Materials International (ASTM):

1. A82, Specification for Steel Wire, Plain, for Concrete Reinforcement.
2. A185, Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
3. A497, Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
4. A615, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
5. A706, Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
6. A767, Specification for Zinc Coated (Galvanized) Steel Bars for Concrete Reinforcement.
7. A775, Specification for Epoxy Coated Steel Reinforcing Bars.
8. A884, Specification for Epoxy Coated Steel Wire and Welded Wire Reinforcement.
9. C1107, Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
10. D3963, Specification for Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars.
11. E8, Standard Test Methods for Tension Testing of Metallic Materials.

C. American Welding Society (AWS)

1. B1.10, Guide for the Nondestructive Examination of Welds.
2. D1.4, Structural Welding Code – Reinforcing Steel.
3. 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. CTM 417, Method of Testing Soils and Water for Sulfate Content.

2. CTM 422, Method of Testing Soils and Water for Chloride Content.

G. American Society for Nondestructive Testing (ASNT)

1. SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing

1.3 SUBMITTALS

A. Submit manufacturer's product data and installation instructions for proprietary mechanical coupler systems when such splicing methods are permitted.

B. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

C. 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.

D. 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.

E. Certificates of Compliance: Submit in accordance with Caltrans Standard Specifications Section 52-1.01C(3), Certificates. For galvanized reinforcing bars, submit certificates of compliance in accordance with ASTM A767.

F. 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.

G. Submit copies of inspection and test reports required in this Section.

H. 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.

1.4 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 and certified by an 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 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.

E. Contractor shall perform ultimate splice testing and submit the results per requirements of Caltrans Standard Specification Section 52-6 Splicing.

1.5 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 injurious contaminants. Steel, which cannot be properly identified, will be rejected and shall be immediately removed from the work in accordance with the project specific General Provisions.

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

2.1 MATERIALS

A. Reinforcing Steel Bars: ASTM A615.

B. Reinforcing Steel Wire: ASTM A 82, cold drawn.

C. Welded Steel Wire Fabric: ASTM A185, uncoated finish. Size shall be as indicated on Contract Drawings.

D. Welded Steel Wire Fabric – Deformed Wire: ASTM A 497, uncoated finish.

E. Welded Steel Wire Fabric – Epoxy-Coated: ASTM A 884.

F. 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.

G. Welding Electrodes: E90 meeting the requirements of AWS D1.4.

H. 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.

I. 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.

J. Ultimate splices shall conform to the requirements of Caltrain Standard Specification Section 52-6 Splicing.

2.2 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.

5. Concrete dobies

2.3 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 50-1.03B, Mixing and Proportioning, and 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.

2.4 FABRICATION

A. Fabricate in accordance with the requirements of ACI 315.

B. Welding:

1. Welding of reinforcement, where indicated and allowed, including preparation of bars shall conform to 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 permitted.

C. Locate splices not indicated on the Contract Drawings at point of minimum stress.

D. 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.

PART 3 - EXECUTION

3.1 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.

3.2 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. No welding of reinforcing steel will be used for splices due to potential loss of rebar strength.

C. Tack welding shall be allowed as required to attach anchor bolt templates to rebar cages.

D. Perform installation of mechanical coupler and tightening for joint assembly in accordance with the coupler manufacturer's installation instructions and recommendations.

3.3 DRILLING AND GROUTING DOWELS

A. Drilling and grouting concrete 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, Miscellaneous Construction, and as specified herein.

B. Dowels shall conform to the provisions for reinforcing steel bars specified herein.

C. 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 with water or compressed air, and allow to dry to a surface dry condition immediately prior to grouting.

D. After placement of reinforcement, seal ends of the drilled hole containing the reinforcement, with one vent tube and an injection feed tube. Place tubes in the hole in a manner which will allow the air to vent and the hole to completely fill 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.

E. 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.

F. If reinforcement is encountered during drilling, before the specified depth is attained, notify Caltrain. Unless Caltrain permits 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.

G. When bonding dowel is approved, bonding shall confirm to the details shown on the Contract Drawings, in the provisions of the Caltrans Standard Specifications Section 51-1.03E(3), Drill and Bond Dowels and as specified herein.

3.4 FIELD QUALITY CONTROL

A. Nondestructive tests of installed welded butt joints shall be performed in accordance with AWS B1.10, Guide for the Nondestructive Examination of Welds.

B. Inspections and tests shall be performed in accordance with the applicable requirements of AWS D1.4, Chapters 6 and 7.

C. Visually inspect reinforcing bar welds.

D. Tension tests of welded butt joints shall be performed on sample welds produced by the Contractor in accordance with ASTM E8.

E. Perform ultimate splice testing per the requirements of the Caltrans Standard Specifications Section 52-6, Splicing.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for cast-in-place Portland cement concrete including mix designs, delivering, and placing.

1.2 REFERENCE STANDARDS

A. American Concrete Institute (ACI):

1. 211.1, Selecting Proportions for Normal-Density and High-Density Concrete Guide.
2. 222.3R, Guide to Design and Construction Practices to Mitigate Corrosion of Reinforcement in Concrete Structure.
3. 301, Specifications for Structural Concrete.
4. 302.1R, Guide to Concrete Floor and Slab Construction.
5. 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
6. 305R, Guide to Hot Weather Concreting.
7. 306.1, Cold Weather Concreting.
8. 308, Standard Practice for Curing Concrete.
9. 318, Building Code Requirements for Structural Concrete and Commentary.

B. American Society for Testing Materials International (ASTM):

1. C31, Standard Test Practice for Making and Curing Concrete Test Specimens in the Field.
2. C33, Specification for Concrete Aggregates.
3. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
4. C94, Specification for Ready-Mixed Concrete.
5. C109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars.
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, Specification for Portland Cement.
9. C171, 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, Specification for Air-Entraining Admixtures for Concrete.
13. C494, Specification for Chemical Admixtures for Concrete.
14. C618, Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in

Concrete.

15. C928, Specification for Packaged, Dry, Rigid-Hardening Cementitious Materials for Concrete Repairs.
16. C989, Specification for Slag Cement for Use in Concrete and Mortars.
17. C1059, Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
18. C1116, Specification for Fiber-Reinforced Concrete and Shotcrete.
19. C1582, Specification for Chemical Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete.
20. D1751, Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
21. E329, 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, Concrete

D. U.S. Army Corps of Engineers, Concrete Research Division (CRD):

1. C621 Nonshrink Grout

1.3 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Concrete Mix Designs: Submit mix designs for each class of concrete. Indicate locations to be used. Include names and brands of materials, proportions, slump, strength, gradation of aggregates. Include laboratory test reports of trial strength and shrinkage tests.

C. Product Data: Submit manufacturer's product data for proposed products, including epoxy adhesive, grout, and concrete admixtures.

D. Shop Drawings:

1. Submit drawings that indicate the locations of all joints in concrete that are not shown on the Contract Drawings, including construction joints, expansion joints, isolation joints, and contraction joints. Coordinate with the requirements specified in Section 03 11 00, 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.

E. Submit for 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.

1.4 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 delivery tickets for concrete delivered to the site in accordance with the requirements of ASTM C94, if required.

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.

1.5 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

2.1 MATERIALS

A. Concrete Materials:

1. Portland Cement: Conforming to ASTM C150 Type II, or V as appropriate for application.
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: Equivalent in quality and performance to one of the following:
    a. DCI or DCI S by Grace Concrete Products.
    b. Rheocrete 222 by Master Builders, Inc.
    c. ISO VMA 9000 by CEMEX

B. Optional Concrete Admixtures and Cementitious Materials: 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. 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. Chemical Admixtures, Plasticizing: ASTM C494 Type F or Type G, high-range water-reducing admixtures.
5. Prohibited Admixtures: Admixtures containing chlorides or sulfides are not acceptable.

2.2 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, or CSS Section 90, as applicable. Ensure that mix designs will produce concrete suited for proper placement and finishing.

C. Concrete mix:

1. Compressive strength for Structural Concrete: 4,000 psi minimum at 28 days, unless otherwise indicated in the Contract Drawings.

2. Compressive strength for Ductbank Concrete: 2,500 psi minimum at 28 days, unless otherwise indicated in the Contract Drawings.

3. Entrained air content: 3 to 4 percent, except as indicated in the following:

a. 2 to 4 percent for concrete with a 28-day compressive strength of 5000 psi or greater.

b. 3 percent maximum for concrete used for cast-in-place concrete station platforms ramps, and stairs.

4. Corrosion inhibitor added in accordance with the manufacturer's instructions; 2 gallons DCI or 1-gallon Rheocrete 222 per cubic yard of concrete, minimum.

5. Design concrete mix for pumping to meet requirements specified herein except that mix may be richer in lubricating components to allow proper pumping, subject to Caltrain's approval.

D. Each trial mix will be developed in accordance with the requirements of ACI 318 and ACI 301, or CSS Section 90.

E. Perform quality control relating to mix design.

F. Concrete Mix for Corrosive Soils: Concrete mix requirements are modified for corrosive soils that contain excessive amounts of chlorides and/or sulfates that interact and corrode reinforcing causing concrete voids and spalling. Corrosive soil due to chloride concentrations contains greater than 500 ppm of chlorides. Corrosive soil due to sulfate concentrations contains greater than 2000 ppm of sulfates with a PH less than or equal to 5.5. The following concrete mix measures mitigate corrosive soil interaction with reinforcing:

1. Minimum compressive strength for structural concrete: 4000 psi minimum with 5000 psi preferred. Ductbank concrete: 4000 psi minimum.

2. Maximum water cement ratio: 0.4 (ACI) with 0.49 (AASHTO) acceptable for some applications such as CIDH foundations

3. Maximum Slump: 4 inches

4. Cement: Type II or V low alkali.

5. Water: Low chloride content from a known controlled supply (i.e., municipal water)

6. Minimum supplemental cementitious content: 675 Lbs. per CY by adding fly ash and/or Slag cement to decrease permeability and improve workability.

a. Fly Ash: ASTM C618, Class F

b. Slag cement: ASTM C989 Grade 120

7. The following chemical admixtures not containing chlorides or sulfides that control water content and inhibit reinforcing reaction are added during the batching process.

a. Air entraining admixture to improve workability for a low water/cement (w/c) ratio: ASTM C260

b. Water-reducing admixture to lower the w/c ratio: ASTM C494, Type F or

Type G

c. Corrosion inhibitor to retard chloride reaction: ASTM C494, Type S and ASTM 1582. Corrosion inhibitor is used in reinforced concrete including ductbank concrete and minor concrete for manhole bases and curbs that is placed within one foot of the ground water level

d. Rheology modifier to retard chloride reaction: ASTM C494, Type S and ASTM 1582

G. Concrete Mix for Wayside ROW Fence and Structures: Concrete mix requirements are modified for wayside ROW fence post foundations and structures that are remote and may involve concrete preparation at the site. Use of a pre-package mix is allowed.

1. Option 1 - Ready Mix- Portland Cement: Conforming to ASTM C150 Type II, or V.

a. Air-entraining mix: Conforming to ASTM C260.

b. Fine aggregate: Conforming to ASTM C33.

c. Coarse aggregate: Conforming to ASTM C33.

d. Minimum compressive strength: 3000 psi minimum at 28 days, unless 4000 psi at 28 days is indicated in the Contract Drawings for corrosivity.

e. Maximum water cement ratio: 0.5

2. Option 2 - Pre-blended Mix of Cement and Aggregates: Quikrete Product No. 1101 or equal conforming to ASTM C387.

a. Minimum compressive strength: 3000 psi minimum at 28 days, unless 4000 psi at 28 days is indicated in the Contract Drawings for corrosivity.

b. Maximum water cement ratio: Water is added per manufacturer's directions. 6 pints for an 80 lb. bag at the start with the final water content between 6 and 9 pints.

H. Grout:

1. Cementitious Grout: Provide a prepackaged, nonshrink, nonmetallic, noncorrosive cement-based grout conforming to the following requirements:

a. ASTM C1107, Grade B or C, as appropriate for the condition or use 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.)

c. SC Multipurpose Grout, Quikkrete Non-Shrink Purpose Grout or BASF MasterFlow 928 may be used to fill the voids on platforms between an OCS foundation edge and the square sawcut lines.

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.

c. Low Viscosity Structural Injection Epoxy Binder conforming to ASTM 881.

3. Hydraulic cement-based, non-metallic, non-shrink, conforming to ASTM C928.

4. Rapid hardening when mixed with water, forming a permanent bond. Initial set shall be in 30 minutes.

5. Compressive strength of 5000 psi minimum in 28 days, conforming to ASTM C109.

I. Expansion Joint Filler: Pre-molded asphalt impregnated felt conforming to ASTM D1751, 1/2-inch, unless otherwise indicated on the Contract Drawings.

J. Bonding Agent: ASTM C1059 for bonding fresh to hardened concrete.

K. Expanded Polystyrene: As specified in CSS Section 51 1.12D.

L. Curing Materials: Refer to Section 03 35 00, Concrete Finishing.

2.3 SOURCE QUALITY CONTROL

A. Perform testing concrete ingredients at their source of supply using an independent testing laboratory.

PART 3 - EXECUTION

3.1 PREPARATION

A. Inspect forms, earth bearing surfaces, reinforcement, and embedded items, and obtain the QC Inspectors written approval before placing concrete, in accordance with the project specific General Provisions.

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.

3.2 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 ponding 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 6 inches slump maximum provided the concrete meets strength requirements, 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.
4. Concrete cover requirements shall comply with ACI Sections 19.3 and 20.6.

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.

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 01 57 20, Storm Water Pollution and Erosion Control (under future development).
2. Do not pump concrete through aluminum pipes.
3. Provide full-time inspection of all pumping operations by a recognized testing laboratory accepted by Caltrain. Refer to Special Provisions Section 01300, Submittals and Deliverables for review.

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.

3.3 CONSTRUCTION JOINTS

A. Construction joints will be permitted only where indicated or approved.

B. Make construction joints straight and as inconspicuous as possible, and in exact vertical and horizontal alignment with the structure.

C. Locate joints 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 03 11 00, Concrete Forming.

E. Use an ACI approved key, at least 1-1/2 inches in depth, at joints unless otherwise indicated or approved by Caltrain.

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, pressure washing 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.

1. The elapse in time before continuing concrete placement at construction joints for tall pedestal CIDH foundations may be reduced from 72 hours to 24 hours with Caltrain's approval based on required supporting documentation.

3.4 CONSOLIDATION

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 adequate type and size per placement method in accordance with Contract Documents. Operate vibrators to reach all concrete areas, with minimal 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 unless indicated otherwise. Broom marks shall not exceed 1/8 inch in depth.

F. Tool all edges with a 2-inch wide, 1/4-inch radius rounded edge.

G. Refer to Technical Specifications Section 03 35 00, Concrete Finishing, for additional finishing requirements.

3.5 CURING

A. Curing Standards: Cure concrete in accordance with applicable requirements of Caltrans Standard Specification Section 51-1.03H Curing Concrete Structures and Section 90-1.03B Curing 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. If curing compound is used, clean concrete surfaces of all loose curing media at the

expiration of the curing period.

C. Damp Curing:

1. Vertical surfaces shall be cured by keeping the forms always wet and by leaving the forms in place as specified in Section 03 11 00, 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: 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.

3.6 FINISHING

A. Refer to Section 03 35 00, Concrete Finishing and Caltrans Standard Specification Section 90, for finishing and curing requirements.

3.7 PROTECTION

A. 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.

B. 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 03 35 00, Concrete Finishing.

C. Do not permit concrete to dry during the curing period because of finishing operations.

D. 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.

E. 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.

F. 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.

G. 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.

H. Maintain a minimum temperature of 50 degrees F in the concrete for not less than 6 days for concrete subject to loads.

I. 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.

J. 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.

3.8 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.

3.9 FIELD QUALITY CONTROL

A. The Contractor will perform field testing listed herein by use of an independent testing laboratory. Test results will be made available to Caltrain. Aid the testing laboratory in taking samples upon Caltrain's request.

1. At least one set of three cylinders made in accordance with ASTM C31 or Caltrans Standard Specification Section 90 and cured under laboratory conditions for each day of placing concrete.
2. At least one slump testing in accordance with ASTM C143 or Caltrans Standard

Specification Section 90, and air content test in accordance with ASTM C138, C173, or C231 made for each day of placing concrete.

3. The three 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 cylinders does not achieve the specified amount, Contractor to do one or more of the following:

1. Additional field testing by coring or impact hammer to determine if in-place compressive strength meets specified requirement. Repair all core holes.

2. Removal and replacement of work.

3. Other procedures determined by Caltrain.

END OF SECTION

SECTION 03 35 00
CONCRETE FINISHING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for the finishing and curing of formed and unformed concrete surfaces, including the repair of surface defects.

1.2 REFERENCE STANDARDS

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

1. M182, Burlap Cloth Made from Jute or Kenaf.

B. American Concrete Institute (ACI):

1. 117, Specification for Tolerances for Concrete Construction and Materials.
2. 301, Specification for Structural Concrete.
3. 308, Standard Practice for Curing Concrete.
4. 503.4, Specification for Repairing Concrete with Epoxy Mortars.

C. American Society for Testing Materials International (ASTM):

1. C33, Specification for Concrete Aggregates.
2. C150, Specification for Portland Cement.
3. C171, Specification for Sheet Materials for Curing Concrete.
4. C309, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
5. C881, Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

1.3. 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.

1.4. SUBMITTALS

A. Refer to Special Provisions Section 01300 - Submittals and Deliverables for review requirements.

B. Product Data: Submit manufacturers' product data for manufactured products.

C. Samples: Review by Caltrain will be for color and texture only. Approved samples will become Caltrain's control samples.

1. Submit samples not less than 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.

D. Submit procedures to achieve uniform treatment of construction joints

1.5. 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 Caltrain'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 Caltrain's approval. Mock-ups may be smaller in size if approved by Caltrain.

3. Provide the number of mock-up panels required necessary to obtain Caltrain's approval of pattern, texture, and color of panel.

4. Include specified concrete coverings, hardeners, sealers, etc as part of the mock-up if requested by Caltrain.

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 Caltrain.

PART 2 - PRODUCTS

2.1 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 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 Caltrain.

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.

2.2 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.

2.3 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.

PART 3 - EXECUTION

3.1 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.

3.2 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 03 11 00, Concrete Formwork, 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 Caltrain'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 Caltrain'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 unless approved otherwise by Caltrain. Maintain patterns of variances in depths of cuts as indicated.

4. Construction Joints: Use technique acceptable to Caltrain 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.

3.3 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 03 30 00, 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" as indicated for exterior sidewalks and paving, garage floors (other than parking garages), exterior ramps, equipment and transformer pads, 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.

3.4 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. Bull floated 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.

3.5 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 03 30 00, 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. 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 for a length of time as specified in Section 03 11 00, 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.

3.6 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 03 30 00, Cast-In-Place Concrete, for additional requirements.

D. Prevent contamination of planting areas during washing of washed aggregate finish.

END OF SECTION

SECTION 26 05 26
SYSTEMWIDE GROUNDING AND BONDING

PART 1 - GENERAL

1.1 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, poles, passenger station platform equipment, impedance bonds. Grounding and bonding of substation equipment, communication equipment and OCS disconnect switches is not included here and is included in other specification sections. Grounding of the CS pole and structures, disconnect switch ground mats and OCS surge arresters is covered under the OCS Grounding and Bonding Specification.

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.

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 project specifications.

1.2 RELATED SECTIONS

A. Section 27 05 26 - Grounding of Communications Equipment

B. Section 34 30 49 - OCS Grounding and Bonding

C. Section 34 31 16 - TPF Grounding and Bonding

1.3 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review 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.

1.4 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. Where multiple codes address the same issue, but specify differing approaches or values, the most stringent requirement shall be met.

1. National Electrical Code (NEC)
2. National Electrical Safety Code (NESC)
3. National Fire Protection Association (NFPA) 101 Life Safety Code
4. Underwriter's Laboratories, Inc. (UL)
    a. Standard No. 467, Electrical Grounding and Bonding Equipment
    b. Standard No. 869, Electrical Service Equipment
5. Institute of Electrical and Electronics Engineers (IEEE)
    a. 80-2000, Guide for Safety in AC Substation Grounding
    b. 81.2-1991, Guide for Measurement of Impedance and Safety Characteristics of Large, Extended or Interconnected Grounding Systems
    c. 141-1993, IEEE Recommended Practice for Electric Power Distribution for Industrial Plants
    d. 142-2007, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems
    e. 837-2002, IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding
6. American Society for Testing Materials (ASTM)
    a. B3-13 (2018), Standard Specification for Soft or Annealed Copper Wire
    b. B8-11 (2017), Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
    c. B187/B187M-20, Standard Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes
7. California Code of Regulations, Title 24 (California Building Standards Code which includes the California Electrical Code)
8. California Public Utilities Commission (CPUC) General Order (GO) 95
9. International Electrotechnical Commission (IEC) 60479, Effects of Current on Human Beings and Livestock – Part 1 General Aspects
10. American National Standards Institute (ANSI), ANSI-TIA-EIA-607-A "Grounding and Bonding Requirements for Telecommunications in Commercial Buildings"
11. NFPA Std. 780, Standard for Installation of Lightning Protection Systems
12. European Standards (EN)
    a. 50119 – 2001, Railway Applications – Fixed Installations – Electric Traction Overhead Contact Lines
    b. 50122-1 – 2011, Railway Applications – Fixed Installations - Part 1. Protective provisions relating to electrical safety and earthing
    c. 50124-1 – 2001, Railway Applications – Insulation Coordination – Part 1. Basic requirements – Clearances and creepage distances for all electrical and electronic equipment
13. The Manual for Railway Engineering of the American Railway Engineering and Maintenance of Way Association (AREMA Manual)
14. U.S. Department of Defense (USDOD) Military Standards

PART 2 - PRODUCTS

2.1 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.

2.2 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 the connection of copper cable tails from ground grids and counterpoise wires to steel structures at passenger stations.

H. 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.

I. All exothermic weld materials including welder, weld metal, handles and all other weld materials shall be supplied by the same manufacturer.

J. 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.

K. 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

3.1 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. Overhead Bridge and Parapet Barriers : TPRS
11. Passenger Station Grounding and Bonding:
    a. Grid under the platform: TPRS
    b. Station Counterpoise Wire: 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).

3.2 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 Overhead Bridges), impedance bonds, passenger station platform structures with ground grids and counterpoise wires.

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 compress 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.

3.3 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 Caltrain.

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. Medium-voltage pad-mounted transformer ground: 5.00 ohms

   d. Medium-voltage pole-mounted transformer ground: 5.00 ohms

   e. Passenger Station Ground Grids and Counterpoise Wires: 5.00 ohms (max). Additional ground rods shall be added to obtain resistance value below this value.

   f. Equipment house for signal and or communication: Ground resistance shall not exceed 15.00 ohms

END OF SECTION

SECTION 31 00 00
EARTHWORK

PART 1 - GENERAL

1.1 DESCRIPTION

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

1.2 REFERENCE STANDARDS

A. American Society for Testing Materials 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 the Sand-Cone Method.
4. D1557, Standard test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft.).
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 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.

1.3 DEFINITIONS

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

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

C. Satisfactory Materials: Any material classified by ASTM D2487 as GW, GP, SW, SP, SC, GM, GC, and SM.

D. Unsatisfactory Materials: Materials that do not comply with the requirements for satisfactory materials. Unsatisfactory materials include those materials containing roots and other organic matter, trash, debris, stones larger than 3 inches, and materials classified in ASTM D2487 as PR, OH, OL, CH, MH, and ML. Unsatisfactory material also includes refuse and other material.

1.4 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review requirements.

B. 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.

C. Submit the following materials:

1. Structure backfill.

2. Pervious backfill material.

3. Slurry cement backfill.

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

E. Submit the following pothole shop drawings if specifically required in the Special Conditions. 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 Caltrain 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.

1.5 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

2.1 MATERIALS

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

1. Materials shall be free from organic matter, excessive fines, or unsuitable products of demolition.

2. Materials shall have a plasticity index of 15 or less, a liquid limit of 30 or less and an expansion index of 30 or less, except where otherwise approved by Caltrain.

3. Backfill shall consist of well-graded sand, gravel, crushed gravel, crushed stone, or crushed slag composed of hard, tough, and durable particles, and shall contain no more than 10 percent by weight of material passing a No. 200 mesh sieve and no less than 95 percent by weight passing the 3/4-

inch sieve. The maximum allowable aggregate size shall be 1 inch. Gradation shall be determined in accordance with ASTM C136 or D422, as applicable.

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 Caltrain.

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 otherwise directed by Caltrain.

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

1. Structure Backfill: Section 19-3.02C, Structure Backfill.

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

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

4. Controlled Low-Strength Material Backfill, Section 19-3.02G.

5. Filter Fabric: Section 96-1.02B, Filter Fabric Class A.

6. Rock Slope Protection: Section 72-2, Rock Slope Protection.

7. Small Rock Slope Protection: Section 72-4, Small Rock Slope Protection.

C. Soil Stabilization Geotextile: Tensar Bi-Axial Geogrid reinforcement or 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: Sand conforming to Caltrans Standard Specifications, Section 19-3.02F (2), Sand Bedding.

E. Tracer Tape (Detectable Tape): Terra Tape Sentry-Line as manufactured by Reef Industries, Houston, Texas, or equal:

Identification	Type	Color
Gas Line	12" Sentry Line	Yellow
Water Line	6" Sentry Line	Blue
Sewer, Drain, Irrigation Line	6" Sentry Line	Green
Electrical Line	12" Sentry Line	Red
Signal Lines	12" Sentry Line	Orange
Fiber Optics Line	12" Sentry Line	Orange

2.2 BIOFILTRATION SOIL MIX

A. Soil for Biofiltration Soil Mix

1. General Requirements – Biofiltration soil mix shall:

a. Consist of the following mixture of fine sand and compost, measured on a volume basis:

60%-70% Sand
30%-40% Compost

2. Submittal Requirements –Submit for approval:

a. Certification from the soil supplier or an accredited laboratory that the Biofiltration Soil mix meets the requirements of this specification.

B. Sand for Biofiltration Soil

1. Sand shall be free of wood, waste, coating such as clay, stone dust, carbonate, etc., or any other deleterious material. All aggregate passing the No. 200 sieve size shall be nonplastic.

2. Sand for Biofiltration Soils shall be analyzed by an accredited lab using #200, #100, #40 or #50, #30, #16. #8-, #4-, and 3/8-inch sieves (ASTM D 422, CTM 202 and meet the following gradation:

Sieve Size	**Percent Passing (by weight)**	
	Min	***Max***
3/8 inch	100	100
No. 4	90	100
No. 8	70	100
No. 16	40	95
No. 30	15	70
No. 40 or No. 50	5	55
No. 100	0	15
No. 200	0	5

Note: all sands complying with ASTM C33 for fine aggregate comply with the above gradation requirements.

C. Composted Material: Compost shall be a well decomposed, stable, weed free organic matter source derived from waste materials including yard debris, wood wastes or other organic materials not including manure or biosolids meeting the standards developed by the US Composting Council (USCC).

1. Compost Quality Analysis by Laboratory – Before delivery of the soil, the supplier shall submit a copy of lab analysis performed by a laboratory that is enrolled in the US Composting Council's Compost Analysis Proficiency (CAP) program and using approved Test Methods for the Examination of Composting and Compost (TMECC). The lab report shall verify:

a. Organic Matter Content: 35% - 75% by dry wt.

b. Carbon and Nitrogen Ratio: C: N < 25:1 and C: N >15:1

c. Maturity/Stability: Any one of the following is required to indicate stability:

i. Oxygen Test < 1.3 O2 /unit TS /hr.

ii. Specific oxy. Test < 1.5 O2 / unit BVS /hr.

iii Respiration test < 8 mg CO2-C /g OM / day

iv Dewar test < 20 Temp. rise (°C) e.

v Solvita® > 5 Index value

d. Toxicity: Any one of the following measures is sufficient to indicate non-toxicity.

i NH4+: NO3--N < 3

ii Ammonium < 500 ppm, dry basis

iii Seed Germination > 80 % of control

iv Plant Trials > 80% of control

v Solvita® = 5 Index value

e. Nutrient Content: provide analysis detailing nutrient content including N-P-K, Ca, Na, Mg, S, and B.

i Total Nitrogen content 0.9% or above preferred.

ii Boron: Total shall be <80 ppm.

f. Salinity: Must be reported; < 6.0 mmhos/cm

g. pH shall be between 6.2 and 8.2 May vary with plant species.

2.3 BIORETENTION AND BIOSWALE SEED MIX

A. Potential seeding options include the following (see product sheets at provided links for reference):

1. Native Ornamental Bioswale Mix (preferred)
http://store.pcseed.com/product/Native-Ornamental-Bioswale-Mix.aspx
2. Native Erosion Control Mix (secondary substitute)
ttp://store.pcseed.com/product/Native-Erosion-Control-Mix.aspx
3. Basic Native Erosion Control Mix (alternative secondary substitute)
http://www.ssseeds.com/product/Basic-Native-Erosion-Control-Mix.aspx
4. Or an approved equal.

B. An alternate to seeding for smaller areas will be a 4" minimum depth of railroad ballast.

C. Please submit product data to Caltrain for review and approval prior to installing.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Groundwater is relatively shallow within portions of the project limits. When encountered, wet subgrade conditions may require preparation and compaction mitigations.

B. Existing Underground Lines and Services: Remove or abandon in place unclaimed, abandoned utilities as indicated.

C. Utilization of Excavated Materials: Use material removed from excavations for backfill, embankment, subgrade, and similar purposes, unless the material is unsatisfactory. Dispose of excess materials as indicated.

D. Use existing salvaged ballast for backfill, bedding, embankment, or fill as designated by Caltrain.

E. Erosion Protection: Provide storm water pollution prevention, dust control, and related requirements as indicated. Protect exposed graded areas from wind and water erosion until stabilization is achieved.

F. Groundwater could be present during earthwork requiring site dewatering. Perform dewatering as necessary and as indicated. Site dewatering should be conducted in accordance with all applicable regulatory requirements.

G. Use Soil Stabilization Geotextile for soil stabilization where indicated.

H. Fill is required to be stable under conditions of flooding, including rapid rise and rapid drawdown, prolonged inundation, and erosion and scour; structural fill compaction is specified, or an engineering report is required, side slopes are required to be no steeper than 1:1.5.

3.2 EXCAVATION

A. Excavate material encountered within the limits of the work, to the lines, grades, and elevations as indicated.

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

B. Remove any existing vegetation, shrubs, trees, and their root systems from areas to be developed. Depressions resulting from the removal of vegetation, rock debris and utilities will be backfilled and properly compacted per the project specification. Vegetation removal should be done in accordance with all applicable regulatory requirements, including BIO-1g (breeding seasons restrictions) and BIO-5 (tree removal).

C. 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 as indicated in the project specific General Provisions.

D. If unsuitable material is encountered during or after excavation to the specified subgrade elevations, the unsuitable material will be removed to one (1) foot below the original planned subgrade or until the material is determined to be suitable for the follow-on work. Work associated with excavation, treatment, handling, and disposal of unsuitable material will be paid as extra work in accordance with the project specific General Provisions. If additional backfill, compaction, or treatment of subgrade after the removal of unsuitable material is required, this work will be paid as extra work in accordance with the project specific General Provisions.

E. Perform excavation and placement of fill in a manner and sequence that will always provide proper drainage.

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

G. Perform measures to correct over-excavation due to error or careless excavation procedures. Over-excavation will not be paid as extra work.

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

I. 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.

3.3 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 otherwise indicated:

1. Structure Backfill: Section 19-3.03E, Structure Backfill.

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

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

4. Controlled Low-Strength Material Backfill, Section 19-3.03I

3.4 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 Caltrain.

B. Unsuitable material and wet subgrade conditions may require over-excavation of 1 to 2 feet at the bottom of a trench and replacement with pervious backfill wrapped in filter fabric, per the direction of Caltrain.

C. 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 Specifications, Section 19-3.03H, Culvert Beddings. Do not use jetting.

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

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

a. Native excavated material approved by Caltrain.

b. Salvaged track ballast approved by Caltrain.

c. Imported Backfill (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 feet of overlap at the end of rolls. If tracer tape depth will exceed tape manufacturer's recommendation, obtain additional instructions from Caltrain before proceeding.

E. Place and compact structure backfill at culverts as indicated 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 is 12 inches or less, backfill structure with slurry cement backfill to the top of the structure.

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

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

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

H. Refer to compaction and field quality control requirements indicated for additional requirements.

3.5 EMBANKMENTS

A. Fill used at the site will be non-expansive material having a Plasticity Index (PI) less than 15.

B. Clear and grub ground surface on which embankment fill is to be placed of live, dead, or decayed vegetation including trees; rubbish; debris; and as indicated.

C. Scarify to a depth of at least 6 inches a prepared ground surface receiving fill, LCC, Aggregate Base, or Aggregate Subbase and moisten to near optimum moisture content and re-compact to at least 95% relative compaction per ASTM D1557 Test Method just prior to placement of embankment materials to ensure bond between embankment material and the prepared ground surface.

D. Construct earth embankments from satisfactory materials free of organic or frozen material. Use no rocks greater than 3 inches. 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.

E. If the required compaction cannot be achieved, over-excavate the subgrade 1 to 2 feet below the finished grade and replace with Aggregate Base, or Aggregate Subbase. A layer of high strength geogrid may be placed at the bottom of the over-excavation, per Caltrain's direction.

3.6 GRADING

A. Grading shall conform to the tolerances indicated. 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 indicated in the project specific General Provisions.

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 indicated. 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 always ditches and drains along subgrade 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 Caltrain'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.

3.7 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 Caltrain 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 Caltrain and obtain Caltrain's approval before further earthwork operations are performed.

C. In addition to proof-rolling, perform field density tests as indicated.

D. Use power-operated or power-driven hand operated equipment wherever possible to compact to requirements indicated. 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 90 percent up to two feet below subgrade elevation and 95 percent within two feet below subgrade elevation, as determined by ASTM D1556.

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

3.8 EXCESS MATERIAL

A. Dispose of material authorized to be wasted outside the jobsite in accordance with the project specific General Provisions for Disposal of Material Outside the Work Site, or at waste areas indicated, 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 indicated for Contractor's use:

1. The limits of the storage location will be designated by Caltrain. 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 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 acceptance of Caltrain.

5. Protect stockpiled soil as indicated. Cover stockpiles with plastic sheeting secured against removal by wind or rain. Daily, inspect plastic sheeting covering stockpiles and make necessary repairs.

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

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

3.9 FIELD QUALITY CONTROL

A. Testing shall be performed by an accepted 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.

3.10 BIORETENTION AND BIOSWALE SEED MIX APPLICATION

A. Bioretention and Bioswale areas should be planted with a seed mix. Hydroseeding is not required as an application method. Hand broadcast of the seed is permissible as long as the seed application rate is adhered to.

B. Seed should be installed per grower recommended process and seeding rate, installation is limited to the rainy season (November to April) seeded areas that do not become established (bare areas larger than 12" square) shall be overseeded the following rainy season.

END OF SECTION

SECTION 34 30 03

OCS GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section describes the general requirements associated with the procurement of materials, manufacture, fabrication, installation, testing services and training necessary to complete the Overhead Contact System (OCS) work in accordance with the Contract requirements.

B. As part of this project, an Overhead Contact System will be furnished and installed within the project limits provided in the Contract Documents The work associated with the Overhead Contact System is shown on the Contract Documents and is generally as follows:

1. Provide a complete OCS for electrification within the Project Limits.

2. Provide a complete OCS for crossovers at interlockings as shown on the plans.

3. Provide OCS sectionalizing equipment at interlockings as shown on the plans and phase break equipment at new traction power facility locations (as required).

4. Provide and connect OCS feeder, auto-transformer feeder (ATF) and return cables to link the OCS/track system to new traction power substations, new traction power switching station and new paralleling (balancing) stations.

5. Provide OCS Operation and Maintenance manuals, As-Built Drawings, Special Tools, Spare Parts and Training of Caltrain personnel.

6. All OCS work shall be fully installed, adjusted, tested and commissioned in place in accordance with applicable portions of these Specifications and as shown on the Contract Documents.

C. The Contractor is responsible to take corrective actions and repair any construction errors, at no additional cost to Caltrain.

1.2 REFERENCES

A. CPUC GO-95, Rules for Overhead Electric Line Construction.

B. CPUC Resolution SED-2, Adopting Safety Requirements Governing the Design, Construction, Installation, Operation, and Maintenance of the 25 kV AC (Alternating Current) Railroad Electrification System of the Peninsula Corridor Joint Powers Board (Caltrain) on The San Francisco Peninsula Rail Corridor.

1.3 QUALITY CONTROL

A. Perform all Work in this Section in strict accordance with the requirements of Section 01400, Quality Control and Assurance.

1.4 SYSTEM CRITERIA

A. Overhead Contact System

1. The overhead contact system for the new work is primarily an auto-tensioned simple catenary, comprising one (1) 70 mm squared 19 strands bronze BZ-II messenger wire and one (1) 107 mm squared CuAg 0.1 copper contact wire.

2. The OCS shall consist of the following styles, as shown on the Contract Documents:

   a. Simple Catenary Auto Tension (SCAT) – constant tension messenger wire and constant tension contact wire between 20^0 F and 145^0 F.

3. The SCAT is to be automatically tensioned (A.T.) using balance weight assemblies, so that essentially constant tension is maintained throughout the specified climatic temperature range, including any related wire temperature rise due to solar and electrical heating.

4. The Contract Documents shall include OCS Technical Sheet drawings, OCS General Arrangement drawings and OCS Assembly drawings.

B. Provide detailed shop drawings and related submittals for all Overhead Contact System equipment, hardware assemblies and components to include:

1. All pole and related pole and downguy foundations drawings;

2. All brackets, mounting and line hardware with insulation (both temporary and permanent);

3. All OCS support and registration assemblies such as cantilevers, portals, headspans or cross-spans, wire pull-offs and all related small part steelwork;

4. All ATF and static wire (SW) support assemblies;

5. All disconnect switches, surge arresters and related taps to the OCS;

6. All balance weight assemblies, mid-point anchor assemblies and fixed termination assemblies, including the down guy assemblies;

7. All in-span materials including hangers, jumpers, section insulators, phase breaks, wire crosses, knuckles and feeder taps;

8. Hanger length calculations and allocations, based on as-built OCS span lengths.

C. Incorporate the guidelines and standards contained in the Contract Documents, including configurations shown on the OCS Technical Sheet drawings, the OCS General Arrangement drawings and the OCS Assembly drawings. Contractor submittals shall be in accordance with the Specification Section for various Work items, and Special Provision Section 01300, Submittals and Deliverables.

D. The OCS hardware, being all the material from the pole face out to, but excluding the conductors, mounting brackets, and aluminum tubing shall be sized and provided primarily by one manufacturer that is experienced in the design, allocation, fabrication and supply of a major portion of the required OCS hardware. Wherever possible use hardware of Imperial System (English units).

E. The Contractor shall be responsible for the complete form, fit and function of all OCS equipment, hardware assemblies and related components supplied on this project. All drawings shall be prepared by the Contractor for approval by Caltrain and shall identify the form, fit and function of the OCS equipment, hardware assemblies and components. The OCS equipment and hardware suppliers shall have not less than five (5) years experience in the manufacture of performance-proven OCS equipment, hardware assemblies and components used on modern high speed electrified rail systems.

F. The Contractor shall also be responsible for any temporary OCS arrangements required to support the staging of the OCS installation work and as necessary to provide continued, uninterrupted service on the existing diesel commuter rail system. Temporary components shall include, but not be limited to: poles, foundations, guy anchors, insulators, feeder/jumper cables, static wires, grounding and terminations.

G. ENVIRONMENT: The Overhead Contact System equipment, hardware assemblies and components shall be capable of operating satisfactorily in an environment as follows:

1. ELEVATION: 10 ft to 115 ft.

2. HUMIDITY: 5% to 95%

3. PRECIPITATION: 2.0" maximum rainfall in 24 hours; 1.5" maximum rainfall in 1 hour, 15" to 20" normal annual rainfall. (Note: snowfall, ice pellets and icing will not be considered).

4. AMBIENT TEMPERATURE:

   a. Highest recorded: 1080 F

   b. Lowest recorded: 150 F

   c. Yearly average: 680 F

5. WIND: Maximum recorded: 58 mph.

6. CLIMATIC CONDITIONS:

   a. For OCS climatic conditions refer to the Design Criteria Chapter 21.

7. LIGHTNING: (Isokeraunic level): 10

8. SEISMIC WITHSTAND CRITERIA: Zone 4 (in accordance with IBC and CBC recommendations)

9. CONDUCTOR TEMPERATURES RANGES: for SCAT conductor tensioning is between 200 F and 1450 F:

   a. Maximum Conductor Temp: 1760 F

   b. Minimum Conductor Temp: 150 F

1.5 CONSTRUCTION

Furnish and install all project specific items, included by not limited to the following:

A. Furnish and install all OCS pole foundations and guy anchor foundations.

B. Furnish and install all OCS poles and pole grounding.

C. Furnish and install OCS support systems including brackets, cantilevers, portals, headspan and cross-span supports, small part steelwork and wire pull-off registrations on required poles.

D. Furnish, string, tension and insulate messenger and contact wires, including fabrication and erection of hangers and power feeder jumpers and taps.

E. Furnish, string, and tension along-track 25 kV ATF feeder conductors.

F. Furnish, string and tension the along-track static wire.

G. Furnish, string and tension the across-track OCS feeder and ATF connections.

H. Furnish and install static wire to track impedance bond connections.

I. Furnish and install balance weight anchor assemblies and mid-point anchors, including tensioning and insulation.

J. Furnish and install fixed termination anchor assemblies, including messenger and contact wire, ATF and static wire tie-in anchors, tensioning and insulation.

K. Furnish and install OCS and ATF feeder cables for all substation/switching stations-to-OCS cable runs.

L. Furnish and install rail return cables for all substation/switching station-to-impedance bond/track cable runs.

M. Furnish and install OCS disconnect switches with operating mechanisms, associated cables, SCADA connections and personnel safety ground mats (where allocated).

N. Furnish and install OCS section insulators.

O. Furnish and install phase breaks and associated grounding and connections.

P. Furnish and install OCS pole identification and safety signs.

Q. Furnish and install surge arresters, with associated grounding.

R. Furnish mandatory and recommended additional spare parts and special tools in accordance with Section 34 30 96, OCS Spare Parts.

S. Furnish and install all necessary temporary material including poles, guys, insulators, feeder/jumper cables, splices, fittings, terminations and miscellaneous items required to enable the catenary system to be constructed in a manner consistent with the existing operation, all civil work sequences and vehicle testing schedules.

    1. The temporary work should incorporate all requirements necessary to construct the OCS in various stages and be coordinated with civil work, the track allocation schedule and/or existing revenue operations.

T. Testing:

1. The Contractor shall obtain Caltrain's test plan and procedures as set forth in these Specifications prior to starting field testing.

2. The Contractor shall perform all tests necessary to ensure that the OCS performs in accordance with these Specifications.

3. Test the OCS and provide field support for start-up and integrated system testing in accordance with the requirements of the Specifications.

4. The Contractor shall provide Systems Integrated Test Procedures for integrated testing.

U. Provide operating and maintenance (O&M) manuals for all OCS equipment.

V. Provide OCS training and related training materials for the Caltrain operating and maintenance personnel, for emergency response personnel at towns and cities along the route, for schools along the route and for public awareness programs.

1.6 CONTRACTOR SUPPORT DURING INTEGRATED TESTING

A. Provide sufficient personnel and equipment to support the Integrated Testing Program.

B. Integrated Testing is the verification testing performed by Caltrain and all systems contractors prior to turnover of the project. The purpose of the Integrated Testing is to confirm that all systems, such as the Electric Locomotives, EMU's, the traction power substations, the overhead contact system, the train control and signals systems, and the communication systems, properly perform as intended by the design in both normal operating and emergency contingency modes.

C. Provide manpower and equipment to support the Integrated Testing program and to maintain the overhead contact system as necessary.

D. In the event of any malfunctions to the overhead contact system, the Contractor shall quickly mobilize his forces, identify the problem and repair and replace the failed items of OCS equipment. The root cause of the malfunction shall be determined and responsibility for the costs shall be in accordance with the Contract.

1.7 WARRANTY OF CONSTRUCTION

A. The warranty period for all goods, supplies, systems and equipment, except spare parts, shall be two (2) years after energization or twelve (12) months after start of revenue service, whichever occurs last. Certain OCS assemblies and/or components may require more than the two (2) year warranty; see separate Specification Sections.

B. The warranty period for spare parts shall either be twelve (12) months from the placement of each spare part into revenue service, or until two (2) years after final acceptance, whichever occurs first. In the event it is necessary to place any spare parts into operation or service prior to the completion of the warranty period, the Contractor warrants and agrees to furnish and deliver free to Caltrain a replacement part to replenish the Caltrain's spare parts inventory.

1.8 NOMENCLATURE

AAR	Association of American Railroads
AC, ac	Alternating Current

Amp or A	Ampere
ANSI	American Nation Standards Institute
Assy	Assembly
ASTM	American Society of Testing and Materials International
AT	Auto-transformer
A.T.	Auto-Tension
AWG	American Wire Gauge
BIL	Basic Insulation Level
BWA	Balance Weight Anchor
CAT	Catenary
C	Celsius
deg	Degree
DC, dc	Direct Current
ea	Each
EMU	Electric Multiple Unit
EN	European Standards
F	Fahrenheit
FDR	Feeder
FTA	Fixed Termination Anchor
FRA	Federal Railroad Administration
FS	Federal Specifications
ft	Feet
F.T.	Fixed Termination
GALV	Galvanized
GRS	Galvanized Rigid Steel
HD	Hard Drawn
Hz	Hertz
in	Inch
kCMIL	Thousand Circular Mils
kJ	Kilojoule
kN	Kilonewtons
kV	Kilovolt
kVA	Kilovolt-Amp
lb	Pound
lbf	Pounds (force)
LF	Linear Feet
LS	Lump Sum
mA	Milliampere
MESS	Messenger
MNHR	Manhour
mm	Millimeters
mo	Month
MPA	Midpoint Anchor
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NESC	National Electric Safety Code
NTP	Notice To Proceed
NIC	Not In Contract
OCS	Overhead Contact System
O&M	Operation & Maintenance
PB	Pushbutton
psi	Pounds Per Square Inch
PVC	Polyvinyl Chloride

QTY	Quantity
ROW	Right Of Way
RMS	Root Mean Square
R,S&I	Rules, Standards and Instructions
SCAT	Simply Catenary Auto Tension
sec	Second
STA	Station, Stationing
SWAT	Single Wire Auto Tension
TBD	To Be Determined
TPSS	Traction Power Substation
UL	Underwriters Laboratory
V	Volt

PART 2 - PRODUCTS

Refer to Products in other Division 34 OCS specification sections.

PART 3 - EXECUTION

A. Refer to Execution in other Division 34 OCS specification sections.

END OF SECTION

SECTION 34 30 06

INTERFACE REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for the various interfaces between the Work indicated in the Contract Documents and work performed by others, as well as for interfaces between the existing Caltrain Commuter Line and the new OCS work.

B. Contractor shall be responsible for the development of all interfaces between the OCS work and work performed by Caltrain Forces and others.

C. Contractor shall cooperate with and respond appropriately to all interface requests within a period of 15 calendar days following receipt of any request.

1.2 REFERENCES

None

1.3 QUALITY CONTROL

A. Perform the Work included in this Section in strict accordance with Section 01400, Quality Control and Assurance.

1.4 SUBMITTALS

A. Submit all submittals in accordance Section 01300, Submittals and Deliverables.

1.5 BASIC INTERFACES

A. Environment

1. Provide OCS materials and equipment that are capable of being operated, stored and maintained without impairment resulting from the impact of the environment of the San Francisco to San Jose area throughout the range of environmental conditions specified in Contract Documents.

2. The majority of the work under this Contract is to be performed on, and directly adjacent to, the existing Caltrain Commuter Rail System. The Caltrain normal operating hours are as published on the Caltrain website.

3. Schedule all work interfacing with the Caltrain Commuter Rail System with the approval of the Caltrain Operations Department and as required by the Contract Documents to minimize disruption of revenue train service.

4. Special Event service schedules may include decreased headway and stacked train, first in - first out, local service, express service and operating hours longer or shorter than those listed on the Caltrain website.

B. Caltrain Interface

1. Conduct all work on the Caltrain Commuter Rail System in full accord with the Caltrain Safety Program Manual." Any conflicts between this Section and the Caltrain Safety Program Manual shall be governed by the latter.

2. Permitted access to operating portions of the existing Caltrain Commuter system on a pre-scheduled basis. Access requests shall be submitted in writing, with at least seven (7) days notice, to Caltrain.

    a. Access requirements will be provided by the Caltrain Operations Department. These requirements will include scheduling, work staging, construction interfacing and the environment under which the work will be accomplished.

    b. Attend weekly meetings to describe the proposed work plan for the next two weeks. These meetings will be used to coordinate and to resolve issues.

3. Any installation or testing which affects existing rail service must be done during the hours as approved by Caltrain and must be completed in sufficient time to minimize disruptions to normal rail service. Supply sufficient, competent employees and resources to assure restoration of scheduled service within the allotted time. Furnish all equipment such as, but not limited to, warning flags, safety vests, flares, phones, and radios, in accordance with all Caltrain safety and access requirements.

4. Any work crew interfacing with the Caltrain Commuter Rail System operations must be supervised by personnel who have attended and been certified at the Caltrain Track Access Course. All personnel must undergo Railway Worker Protection (RWP) training. Coordinate for times, dates and locations to attend this class.

5. Work which does not affect train operations may be performed, with the authorization of Caltrain, during pre-approved rail operation hours. General Orders/Bulletins, as required, will be issued by Caltrain. Caltrain will furnish the required number of qualified flagmen, watchmen or other employees as may be deemed necessary for safe and continuous operations. Submit to Caltrain at least ten (10) working days prior to implementation, detailed procedures, including an itemized time schedule and breakdown of the labor force. Caltrain has the right to determine the number of qualified flagmen necessary, based on the submitted plans.

6. Provide lighting and electric power, where not specifically provided by others.

7. Caltrain will furnish rail vehicles and vehicle operators, as appropriate, at no cost for the testing as specified in the Contract Documents.

C. Operating Rail Line Interface :

1. Submit an installation and cut-over sequence plan for all areas of construction which affect existing Caltrain Commuter Rail operations. Coordinate the work and cut-over schedules with all involved sub-contractors. Submit the installation and cut-over plans within ninety (90) days prior to commencing any field installation work. Include as a minimum, the following:

    a. Narrative descriptions and schematics for temporary or interim work, methods and materials

    b. Descriptions for the implementation and sequencing of tests as specified in Sections 34 30 86, OCS Testing

c. Installation methods and sequencing implementation

d. Narrative descriptions and schematics to maintain existing operations and rail traffic

2. Ground OCS conductors immediately after installation, in a manner subject to approval. OCS conductors are to remain grounded until such time as they are placed in service. Ground in a similar manner, all other aerial conductors within 10 feet of the OCS which are not in service.

3. Coordinate all interface work.

4. Excavations made adjacent to the trackwork area shall not remain open more than forty-eight (48) hours and must be cordoned off and covered to prevent a hazardous condition to the public, Caltrain employees and Contractor personnel. Refer to Specification Section 34 30 33, CIDH Foundations, for requirements associated with drilled excavations adjacent to the trackwork area.

5. Protect at all times, existing equipment and facilities while working on the system. Any damage to the existing system shall be repaired to Caltrain's satisfaction at no additional cost to Caltrain.

D. EMU Vehicle Interface:

1. The EMU vehicle and pantograph characteristics will be made available from Caltrain upon request.

2. Train Consist:

a. The standard train for the purpose of testing will consist of 6 EMU cars.

b. Under normal operations, the train will consist of 6 cars coupled together during rush hours and special events and 2 - 4 cars at all other times.

3. The electric locomotive and EMU vehicle dynamic profiles will be provided upon award of Contract.

4. All furnished equipment must be fully compatible with the electric locomotive and EMU vehicles and vehicle equipment, including EMI.

E. Caltrain Commuter Rail Line Interfaces:

1. Do not disrupt, inhibit or in any way interfere with Caltrain's Commuter Rail revenue service.

1.6 INTERFACES WITH SIGNAL SYSTEM

A. Coordinate the layout and installation of the OCS structures with the layout and installation of the existing and new wayside signal equipment (i.e., gates, flashers, signal aspects, pushbuttons, etc.).

1.7 INTERFACES WITH TRACTION POWER FEEDERS AND PHASE BREAKS

A. The OCS installation shall address interfaces with traction power feeders, gantries for 25 kV disconnect switches, and phase breaks.

PART 2 - PRODUCTS

Not applicable

PART 3 - EXECUTION

Not applicable

END OF SECTION

SECTION 34 30 13

OCS BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for furnishing and testing of electrical materials and installation methods for the electrical work applicable to the construction of the Overhead Contact System (OCS) specified on the Contract Documents and in other Sections.

B. The work in this Section relates to the integration and connection of various parts, subassemblies, and assemblies of the OCS with each other and other systems.

C. The requirements of the OCS basic electrical materials and methods shall be supplemented by other Sections of the OCS specifications.

1.2 QUALITY ASSURANCE

A. Materials specified shall meet the requirements of applicable sections of the OCS related Work.

B. Tests shall be performed on materials and certified by the Manufacturer.

1.3 REFERENCE STANDARDS

A. American National Standards Institute (ANSI):

1. C80.1, Specifications for Rigid Steel Conduit, Zinc Coated.

B. American Society for Testing and Materials (ASTM):

1. B633, Specification for Electrodeposited Coatings of Zinc on Iron or Steel.

2. D149, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.

3. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

C. Federal Specifications (FS):

1. W-F-408, Fittings for Conduit, Metal, Rigid (Thick Wall and Thin Wall) (EMT) Type.

D. National Electrical Manufacturers Association (NEMA):

1. RN 1, Polyvinyl-Chloride Externally Coated Galvanized Rigid Steel Conduit.

2. WC 7, Cross-Linked-Thermosetting-Polyethylene Insulated Wire and Cable.

3. WC 8, Ethylene-Propylene-Rubber Insulated Wire and Cable.

4. WD 1, General Purpose Wiring Devices.

E. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC).

F. Underwriters Laboratories (UL):

1. 6, Rigid Metal Conduit.

2. 83, Thermoplastic-Insulated Wires and Cables.

3. 467, Grounding and Bonding Equipment.

4. 1059, Terminal Blocks.

5. 1581, Referenced Standard for Electrical Wires, Cables and Flexible Cords.

G. DIN Standards:

1. DIN standards are applicable to hardware and wires as indicated in the Contract Documents.

1.4 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Submit manufacturer's descriptions, shop drawings, installation and operational instructions for all material described in this Section which is utilized in the work.

C. Submit the following OCS arrangements and designs:

1. OCS Crossover Arrangement

a. OCS Jumpers Arrangements

b. Section Insulator Span Hanger Lengths Calculations

2. OCS Insulated Overlap Arrangement – Single Track

a. OCS Jumpers Arrangements

b. Overlap Span and Anchor Spans Hanger Lengths Calculations

3. OCS Uninsulated Overlap Arrangement – Single Track

a. OCS Jumpers Arrangements

b. Overlap Span and Anchor Spans Hanger Lengths Calculations

4. OCS Insulated Overlap Arrangement – Multiple Track

a. OCS Jumpers Arrangements

b. Overlap Span and Anchor Spans Hanger Lengths Calculations

5. OCS Uninsulated Overlap Arrangement – Multiple Track

    a. OCS Jumpers Arrangements

    b. Overlap Span and Anchor Spans Hanger Lengths Calculations

6. OCS Mid-Point Assemblies – Single Track and Multiple Track

    a. Retainer Cables

    b. OCS Jumpers Arrangements

7. Static Wire to Static Wire Across-Track Connection

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide materials and equipment which will fit within the space provided.

B. Where the finish of equipment or material is specified, provide the finish exactly as indicated in the Contract Documents. Where no finish or color is specified, provide the manufacturer's standard finish, suitable for the environment intended. Standard finish must be submitted to Caltrain for review and approval.

C. Furnish and install the materials and equipment to ensure satisfactory operation and operational life in the environmental conditions where the materials or equipment will be installed.

PART 3 - EXECUTION

3.1 GENERAL

A. Perform installation work in accordance with applicable requirements of CPUC General Orders (GO) 26D, GO 95, CPUC Resolution SED2, and NFPA 70.

B. Install and connect all materials and equipment in accordance with the manufacturer’s recommendations.

3.2 OCS WIRING DEVICES

A. Wire Termination: Terminate OCS conductors with approved connectors as indicated on the Contract Documents.

B. External wiring between electrical equipment shall be accomplished as shown on the Contract Documents and as specified in other Sections.

3.3 TESTING

A. Perform testing as indicated in the Specifications for OCS related work items.

END OF SECTION

SECTION 34 30 33

CIDH FOUNDATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for the fabrication, supply, and installation of cast-in-drilled-hole (CIDH) foundations for the Overhead Contact System (OCS) as shown on the Contract Drawings and specified herein. These foundations include the following:

1. Cast-in drilled hole (CIDH) Foundations for OCS Poles and Structures

2. CIDH Foundations for OCS Downguys

3. Alternate Rock Anchor Foundations for OCS Poles and Downguys shall be provided as required.

B. The Section also includes provisions for conduit requirements and installation for special cases where OCS foundations are designed to support Traction Power, Traffic, Civil, Roadway, Electrical, Lighting, Signals and Utilities equipment.

C. Work Included:

1. Foundation layout.

2. Augering and excavation of CIDH foundations.

3. Earth and rock excavation and backfilling.

4. Cast-in-place concrete foundations including formwork, reinforcement, grounding, conduits, anchor bolts, bearing plates and concrete.

5. Rock foundations and anchors (if required), including formwork, reinforcement, grounding, conduits, anchor bolts, epoxy resin grouting and concrete.

6. Pull-out tests when required.

1.2 REFERENCE STANDARDS

A. The following Codes, Regulations, Reference Standards and Specifications apply to work included in this Section:

1. ASTM: A36, A82, A153, A252, A449, A563, A668, A706, C31, C33, C39, C94, C143, C150, C171, C172, C260, C309, C494, C827, C618, C619, C881, C882, C989, C1582, D149, D570, D635, D638, D695, D790, D1785, D2240, D4549, E154 and F1554

2. ACI: 222.3R, 301, 304, 305, 306, 315, 318, 336, 347

3. FS: MMM-G-650 Joint Bonding Agent

4. CRSI: 63, 65, Manual of Standard Practice

5. CBC: California Building Code

1.3 SUBMITTALS

A. Refer to Special Provisions Section 01300 – Submittals and Deliverables for review process.

B. Manufacturer's Data:

1. Submit the manufacturer's specifications with application and installation instructions for proprietary materials and items.

C. Samples:

1. Submit samples of materials as specified and as otherwise directed, including names, sources, and descriptions.

D. The material certificates shall certify that each material item meets or exceeds the specified requirements.

E. Submit product data and manufacturer's installation instructions for specified products.

F. Submit copies of Certificates of Compliance for each lot of concrete delivered to the site.

G. Furnish the following information for each CIDH OCS foundation on the As-Built drawings:

1. Structure location number, identify which track foundation is referenced to and measured along-track location by baseline stationing.

2. Final installed distance from top of foundation to individual low rail level of track served and final installed offset from centerline of foundation to centerline of track served.

3. Type of foundation, including installed depth, giving standard reference number from Contract Drawings.

4. Note any dimensional changes and unique or unusual events during excavation or concrete operations.

H. For each group of foundations, submit the following:

1. Date of pour.

2. Test Results.

3. Delivery ticket number for concrete used or equivalent documentation for concrete prepared on-site.

I. After foundation is poured, submit certification from a registered land surveyor in the State of California that foundation location work is within specified tolerances.

J. Submit Shop Drawings for steel bar reinforcement, bearing plates, anchor bolts, anchor rods. Indicate sizes, spacings, locations and quantities of reinforcing steel, wire fabric, bending and cutting schedules, splicing, stirrup spacing, supporting, and spacing devices. Indicate pertinent dimensions, material types, and arrangement of joints and ties for the formwork. Have Shop

Drawings sealed by a professional engineer registered in the State of California, unless otherwise indicated by Caltrain.

K. Submit detailed description of procedure, equipment, and rig to be used for pull-out tests associated with rock anchored reinforcing bars and rock anchored downguys.

L. Submit current calibration certificates of all testing equipment to be used for the pull-out tests.

M. Submit all pull-out test results noting acceptance or failure of tests.

N. Submit certificates from the mill for manufacture and strength tests for each delivered lot of anchor rods.

O. Submit detailed descriptions of the methods of construction for foundations including types of field equipment, operations and alternative procedures or remedial action for rejected holes.

1.4 QUALITY ASSURANCE

A. Design Mix:

1. Once a design for any class of concrete is issued an approval by the Caltrain, it shall not be varied as to source, quantity, quality, grading of materials, or proportioning, or in any other way.

2. All proposed changes shall be accomplished by preparing a new design mix as specified.

3. Provide mix designs especially suited for various methods of OCS foundation construction.

B. Sampling and Testing: Sample concrete ingredients prior to use and have them tested by a laboratory for which Caltrain has issued an approval, in accordance with the methods specified.

C. Construction Tolerances

1. Locate the center of the OCS pole foundations horizontally within the following tolerances:

a. Along track: Plus or minus 2 feet (for ballasted track areas), or plus or minus 1 foot (for direct fixation track areas).

b. Across track: Plus or minus 2 inches (for ballasted track areas), or plus or minus 1 inch (for direct fixation track areas).

c. Plumb: Drilled pier out-of-plumb dimensions shall be checked after excavation and before concreting. The maximum tolerance shall be 6 inches out-of-plumb within each 10 feet of excavation depth. This tolerance applies to the diameter dimension as shown on the plans, and it does not include excavation over-cutting when it occurs. Excavations which exceed this tolerance shall be rejected, backfilled and the drilled pier relocated to an approved location.

2. Locate downguy foundations horizontally within the following tolerances unless otherwise specified:

a. Along track: Plus, or minus 12 inches relative to the center of OCS pole foundation being anchored (for ballasted track areas), or plus or minus 6 inches relative to the

center of OCS pole foundation being anchored (for direct fixation track areas).

b. Across track: Plus, or minus 2 inches (for ballasted track areas), or plus or minus 1 inch (for direct fixation track areas).

3. The tops of all foundations and anchors shall be within 1 inch above or below the required levels, as shown on Contract Drawings.

4. Should any of the above tolerances prove to be unachievable due to field conditions, immediately notify Caltrain in accordance with the project specific General Provisions, for further direction.

5. Cut and bend reinforcing steel to conform to dimensions as shown on the Contract Drawings within the following tolerances:

   a. Shear length: Plus, or minus 1 inch

   b. Stirrups, ties, and spirals: Plus, or minus 1/2 inch

   c. All other bends: Plus, or minus 1 inch

6. Install OCS pole foundation anchor bolts plumb and within the following tolerances relative to the top of the foundation:

   a. Horizontal: Plus, or minus 1/8 inch off square, the center of which shall meet the tolerance requirements of the foundation.

   b. Vertical: Plus, or minus 1/4 inch.

   c. Provide rigid templates for all anchor bolts to ensure correct alignment. Leave template in place for minimum of three days.

   d. Rotational Tolerance in Relation to Track: As shown on Contract Drawings

7. Conform foundation size to the dimensions shown on the Contract Drawings within a tolerance of plus or minus 1 inch while maintaining nominal concrete cover.

PART 2 - PRODUCTS

2.1 CONCRETE

A. Cement: ASTM C150, normal - Type II or V Portland, gray color, as specified in Section 03 30 00, Cast-in-Place Concrete. Use only one brand of Portland cement throughout the project unless it has been submitted for and received an approval to do otherwise.

B. Compressive Strength (28 days): 4000 psi.

C. Maximum aggregate size 1 ½".

D. Slump: Maximum as per requirements of concrete application and placement method.

E. Concrete Mix Requirements for Corrosive Soils: Corrosive soil contains excessive amounts of chlorides and/or sulfates that interact and corrode reinforcing causing concrete voids and

spalling. Corrosive soil due to chloride concentrations contains greater than 500 ppm of chlorides. Corrosive soil due to sulfate concentrations contains greater than 2000 ppm of sulfates with a PH less than or equal to 5.5. The following concrete mix measures mitigate corrosive soil interaction with reinforcing:

1. Minimum compressive strength for structural concrete: 4000 psi minimum with 5000 psi preferred.

2. Maximum Water/Cement Ratio: 0.49 (AASHTO)

3. Maximum Slump: Maximum per requirements of concrete application and placement method.

4. Cement: Type II or V low alkali

5. Water: Low chloride content from a known controlled supply (i.e., municipal water)

6. Minimum supplemental cementitious content: 675 Lbs. per CY by adding fly ash and/or Slag cement to decrease permeability and improve workability

    a. Fly Ash: ASTM C618, Class F

    b. Slag cement: ASTM C989 Grade 120

7. Chemical admixtures not containing chlorides or sulfides that control water content and inhibit reinforcing reaction and are added during the batching

    a. Air entraining admixture to improve workability for a low c/w ratio: ASTM C260

    b. Water-reducing admixture to lower the w/c ratio: ASTM C494, Type F or Type G

    c. Corrosion inhibitor to retard chloride reaction: ASTM C494, Type S and ASTM 1582

    d. Rheology modifier to retard chloride reaction: ASTM C494, Type S and ASTM 1582

2.2 FORM MATERIALS

A. Provide concrete forming in accordance with Section 30 11 00 Concrete Forming and as specified below for types of formwork shown.

B. Steel Casing (temporary): Galvanized Corrugated Steel Drain Pipe, AASHTO M218 and ASTM A929, thickness equal to or greater than 0.064 inch.

C. Fiberglass forms: For circular formed shapes only, shall be designed specifically for use as a concrete form, diameter as required, removable, multiple uses with proper cleaning of residue.

D. Treated Paper (cardboard): For circular formed shapes only, shall be designed specifically for use as a concrete form, with waterproof surface treatment, diameter as required, removable, one use only.

2.3 REINFORCEMENT

A. Provide reinforcing steel in accordance with Section 03 20 00, Concrete Reinforcing and the Contract Drawings.

B. A maximum unreinforced length of 2 feet may be allowed at the base of the foundation with Caltrain's approval.

2.4 CURING MATERIALS

A. Provide curing material and methods in accordance with Sections 03 30 00, Cast-in-Place Concrete and 03 35 00, Concrete Finishing.

2.5 ANCHOR RODS AND ANCHOR BOLTS

A. High-strength carbon steel bolts; ASTM F1554, Grade 55 S1, unless otherwise noted on the Contract Drawings. Bolts shall have over-tapped threads in accordance with AISC requirements for UNC Series. Provide certificates from the mill for manufacture and strength tests for delivered lot. Anchor bolts and anchor rod assemblies shall be hot-dip galvanized. Nuts shall comply with ASTM A563, Grade C, hot-dip galvanized, overtapped threads in accordance with AISC requirements for UNC series. Washers shall comply with ASTM F436, Type 1, hot-dip galvanized.

B. Anchor Bolt Template: ASTM A572, Grade 50, Hot dipped galvanized.

C. Galvanizing shall comply with ASTM A153.

2.6 CLEVIS CONNECTOR AND COUPLER SLEEVE

A. Forged steel; ASTM A668.

B. Galvanizing complying with ASTM A153.

2.7 GROUND WIRE

A. Ground wire, where required, shall be ASTM B3 annealed, soft-drawn, bare copper, unless otherwise indicated, of class "B" strand, with 98 percent conductivity.

B. The size of grounding cables shall be as shown on the Contract Drawings. Where not indicated, grounding cables shall conform with the requirements of the National Electrical Code. Minimum size shall be 4/0 AWG.

2.8 PVC CONDUITS

A. Comply with the requirements of Section 34 31 13, Basic Electrical Materials and Methods for Conduit (under future development). The size shall be as shown on the Contract Drawings.

2.9 NON-SHRINK GROUT

A. ASTM C150 pre-mixed compound with non-metallic aggregate, cement, water reducing and plasticizing agents; capable of minimum compressive strength of 3500 psi. Shrinkage shall be in accordance with ASTM C827. Other types may be used subject to Caltrain's approval.

2.10 EPOXY- RESIN GROUT

A. Where rock embedment for Downguys and reinforcement bars is required, the embedment shall be by means of cementing the anchor or re-bar into a drilled hole, which shall be filled with epoxy-resin grout after the anchor or re-bar is inserted. The epoxy-resin grout may be mixed at the site and poured into the holes or may be provided in prepackaged cartridges for insertion into the anchor hole.

B. Epoxy-Resin Grout: 2 component, mineral-filled, epoxy-polysulphide polymer complying with FS MMM-G-650, Type I or II, Grade A. Compressive strength of the mixed and cured resin shall be not less than 14,000 psi when tested in accordance with ASTM C39.

C. When the pre-packaged option is selected, provide resin cartridges with a casing constructed of a saturated polyester providing optimum resistance to moisture but easily ruptured to enable complete mixing and integration with hole side walls during installation and containing two distinct fractions of unsaturated polyester resin and catalyst without an intervening mechanical membrane. The resin shall be high strength polyester with non-reactive inorganic filler. The catalyst shall contain peroxide with a non-reactive inorganic filler. The materials shall have thixotropic and viscous properties to permit adequate mixing of the materials by manipulating the embedded rod or bar. The shelf life of the epoxy-resin shall be not less than six months. Gel and cure time shall be within 10 minutes after completion of installation.

D. Products offered by manufacturers complying with the requirements for epoxy-resin type grout include the following:

1. 32 Hi-Mod.; Sika Chemical Corp
2. Epoxtite; W.R. Grace
3. A-H Poly-Epoxy Bonding #100; Anti-Hydro Waterproofing Company
4. Euco Epoxy System 452; Euclid Chemical Company
5. Polytops 40; Chem-Masters Corporation
6. Sonobond; Sonneborn-Contech
7. Probond ET-150; Protex Industries

2.11 BACKFILL MATERIAL

A. Provide backfill material in accordance with Section 31 00 00, Earthwork.

2.12 SLURRY DRILLING FLUID

A. Slurry drilling fluid is for use when selected as an optional drilling method using a liquid slurry to displace ground water and to maintain sides of excavation in uncased drilled holes. The slurry drilling fluid shall consist of water mixed with very fine-grained solids and beneficial admixtures, meeting the requirements of ACI 336.1.

PART 3 - EXECUTION

3.1 PREPARATION

A. The installation of all OCS pole and downguy foundations shall be scheduled and performed so that each pole shaft excavation has the entire concrete placement completed the same day as the excavation and drilling operations are completed. At the end of a shift, if concrete is not placed in the foundation, temporary casing with a cover will be used to support the excavation. All required foundation materials including reinforcement, anchor bolts, rods, conduits and bonding and grounding hardware shall be ready and available for placement without delay. An exception to this requirement shall be allowed for as described in Part 3.2.K.5 of this Section.

B. Do not allow external vibration or excessive wheel loads within the immediate vicinity of any excavation. Maintain sides of excavations always stable.

C. Identify lines, levels, and datum for required foundation work.

D. Without exception, locate and stake out all foundation locations and determine all foundation elevations so that the positions are verified prior to installation. Any locations having potential clearance problems shall be reported without delay.

E. Protect excavations by shoring, bracing, temporary casing or other methods required to prevent cave-in or loose soil from falling into the excavation.

3.2 EXCAVATION

A. Excavate all material required for installation of CIDH OCS foundations to the designed embedment depth.

B. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions. Remedial work shall be performed to correct the situation.

C. General water control: Prevent surface and/or subsurface water from flowing into excavations and from flooding project site and surrounding areas.

1. Do not allow water to accumulate in excavations. Continually remove water to prevent softening of foundation bottoms, undercutting footings or slabs, and soil changes detrimental to stability of subgrades and foundations.

2. Provide and maintain all dewatering system components necessary to convey water away from excavations to approved collecting or run-off areas.

D. In excavating (by mechanical or hand methods), do not disturb the bottom of the excavation. Trim bottoms to required lines and grades leaving a solid base to receive concrete. Excavations shall be stable and shall not affect the integrity of adjacent structures.

E. When excavation has reached required dimensions and below-grade elevations, provide notification to allow for inspection of the conditions. If unsuitable bearing materials are encountered at the required subgrade elevations, cease all work on the foundation and provide notification for further direction.

1. Unsuitable material is defined to include cinders, organic soil, highly plastic clay, soft or saturated soil, vegetation, or other deleterious substance having poor bearing capacity.

Unsuitable material is further defined in Section 31 00 00, Earthwork.

2. If the excavation for an OCS pole foundation or downguy is oversized in any dimension, the additional excavated space shall be filled with concrete. The use of other types of backfill is prohibited.

F. Drilled pier foundation excavations shall be made by mechanical auger or rotary drill, cased or uncased. Augers shall be of a vented design to prevent suction in the hole during bit removal. Excavated holes shall be of the size required for placing concrete directly against the excavated undisturbed vertical soil surfaces, obtaining sizes shown on the Contract Drawings.

G. Selecting a method of excavation at each foundation site which meets all contract requirements and site conditions. Make use of all existing subsurface information to determine the nature of subsurface soils and presence of ground water, in selecting an excavation procedure that will permit placement of the reinforced concrete pier foundation in a cleared water-free excavation, or a slurry-filled excavation.

H. Select the methods and equipment to be used to excavate the drilled pier foundation and maintain the excavation in a manner suitable to install all reinforcement, anchor bolts and deposition of concrete. Excavations which do not meet contract requirements shall be backfilled and new excavations made at the Contractor's expense. Drilling excavation methods which are unsuccessful due to soil cave-ins or presence of ground water shall utilize a different method more suited to conditions which will obtain excavated holes that meet all specified conditions.

I. If, after a drilled pier foundation site has been excavated, the excavated hole cannot be kept free of standing ground water or the side soils are loose and caving in, Caltrain retains the right to issue a rejection for the excavation for use and deny payment for the work. The excavation shall be backfilled, and the required foundation site shall be relocated away from the rejected hole. The drilling/ excavation procedure shall be modified as required to obtain acceptable holes.

J. In all cases, each drilled pier excavation must be free of standing ground water, and loose soil at the bottom which forms a layer more than 3" thick prior to placement of the reinforcement and concrete. A slurry drilling fluid may be used to displace the ground water and stabilize the sides and bottom of the hole. When slurry drilling fluid is used, provide an easily manipulated feeler/measurement rod which can be used to verify depth of hole, plumb tolerance, width at bottom and condition of bottom surface.

K. When solid rock is encountered during excavation, an alternate style foundation in accordance with the criteria shown on the Contract Drawings shall be provided.

1. Rock shall be defined as a mass of solid aggregate of one or more minerals or mineraloids. Weathered or decomposed hardened matter that is more than 1/3 soil shall not be considered rock.

2. Excavate and remove rock by hand or mechanical methods. Explosives are not permitted.

3. Cut away rock in the excavation to form level or otherwise acceptable bearing surface.

4. Remove shale layers to provide a sound and un-shattered base for foundations and anchors.

5. Do not leave rock surfaces, which are intended to serve as foundation bearing areas, exposed for more than 48 hours prior to concreting. Where the rock surface is subject to rock anchor testing that is scheduled to occur more than 48 hours after initial exposure, cap

the rock surface with 2 to 3 inches of concrete after installation of the rock anchor. All open excavations shall be protected as described in Section 31 00 00, Earthwork.

6. In all cases, the bearing surface of the rock foundation shall be clean and free of any rock spoil, soil, and water.

L. In the urban environments along the corridor, be responsible for conducting the work such that the following public space concerns are addressed:

1. Removal and replacement of existing concrete, roadway surfaces, sidewalks, pavers, curbs, and existing slabs. Return to like-new previous condition in accordance with applicable City and township requirements.

2. Protection of open excavations and holes, including warning tape, fencing, and steel capped cans, to prevent public from falling into an open hole or excavation. Follow all applicable City and township requirements for protecting the public.

3. Removal of spoils from all roadways, sidewalks, and existing areas.

3.3 FABRICATION AND PLACING REINFORCEMENT, ROCK ANCHORS AND ANCHOR BOLTS

A. Reinforcement for OCS foundations and anchors shall be fabricated and installed as specified in Section 03 20 00, Concrete Reinforcing, and as follows:

1. Bar reinforcement for drilled pier foundations shall be placed, positioned and secured to prevent movement prior to any concrete placement. In no case shall bars, prefabricated bar cages or anchor bolts be pushed or lowered into fresh concrete which has been placed in an excavated hole prior to reinforcement placement. The reinforcement assembly shall be fitted with devices which assure that the required concrete cover over bars will be obtained.

B. Provide spare nuts and washers for the OCS pole anchor bolts which comply with these Specifications. The spare nuts and washers shall consist in quantity of 5% of the amount installed of each size, rounded higher to the next full number of nuts or washers. These spare nuts and washers shall be delivered to Caltrain at a location specified by Caltrain.

C. Prior to final installation of reinforcing bar rock anchors, all overburden of soil, decomposed rock and layered unstable rock shall be excavated to obtain a surface of stable foundation rock. The pattern of anchor holes shall be accurately marked on the rock surface. Anchor holes shall be drilled with equipment that will provide an anchor hole diameter which is in accordance with the epoxy resin grout manufacturer's recommendations.

1. Insert the proper volume of epoxy resin grout required in accordance with the manufacturer's recommendations for the anchorage conditions, into the drilled hole.

2. A pre-packaged epoxy resin grouting system may be used in which tubes of the packaged material are inserted into the drilled hole before the anchor is inserted. Follow manufacturer's instructions for installation of grouting system and reinforcing rods.

3. In-place pull-out test:

a. Perform testing in the presence of Caltrain to verify that the specified tension can be sustained by the reinforcing bar and anchorage without yield of the steel or rock

or slip of the anchor and to check the grouting procedure and the grout strength.

b. Conduct the pull-out test as follows:

i. Test all Grouted Rock Anchors for down guys.

ii. Test one anchored reinforcing bar, selected at random, in the first rock pole-type foundation constructed and in other foundations as directed.

c. Provide and maintain in good working condition the equipment to be used for performing pull-out tests.

d. Provide pull-out test equipment consisting of a suitably sized hollow ram jack, adjustable bearing truss for aligning the direction of pull with the centerline of the bar, an extension for attaching the jack to the bar, a hydraulic pump with a gauge calibrated to read directly in pounds for the ram being used, a dial gauge which reads in increments of 0.001 inch over a range of at least one inch, a magnetic or independent dial gauge mounting, cribbing and all other necessary accessories. Submit procedures and details of testing rig and equipment prior to any tests.

e. Test rock anchored bars not earlier than recommended by the epoxy manufacturer, nor later than 72 hours after installation into rock. Test shall be completed and accepted prior to construction of the concrete foundation.

f. Pull-out test loads shall be calculated based on 30,000 pounds per square inch of cross-sectional area of the steel bar being tested, and actual jacking pull-out load will vary with the diameter of the rod or anchor bar being tested. The pull-out test load shall be applied and held constantly for one hour, and then released in gradual increments. A record of any bar movement shall be made by measurement of bar deflection or extension, by applying the distance measurement gauge to a fixed point on the test bar. The fixed point shall be located at or near the top of the bar, but not on the jack grips. The movement gauge shall be mounted independently of the jacking frame and crib.

g. The reaction bearing zone of the testing rig shall be a minimum of 5 feet horizontally from the point where the tested bar is grouted into rock.

h. The tested bar or anchor shall have passed the test if the following criteria are met or exceeded:

i. The steady load test pressure, expressed in units of force, did not vary more than 5% below the calculated test load during the one-hour test period.

ii. The movement of the fixed point on the test bar or anchor did not exceed 0.2 inches at the test conclusion.

iii. All other test functions were normal, and no equipment failures occurred.

(a) When a tested anchor or bar fails the pull-out test, it shall be rejected from further use. In the event of such a failure, evaluate the cause of the failure, develop a remedial action, install another anchor at a site and re-test. Grouted bars or anchors which are

successfully tested shall be accepted and incorporated into the foundation or anchor structure construction.

3.4 INSTALLING CONDUITS

A. Install electrical conduits and stub-ups in OCS foundations, if required, as shown on the Contract Drawings.

B. Use the size, type and general routing as shown on the Contract Drawings, including but not limited to Traction Power, Traffic, Civil, Roadway, Electrical, Lighting, Signals and Utilities, and as specified in Section 34 31 13 (under future development).

C. Install conduit bends in accordance with NEC.

D. Support conduits to prevent movement, distortion, and damage during placement of concrete.

E. At all stages of the work, exercise care to prevent foreign materials from entering the conduits.

F. The ends of conduits shall be capped and installed with pull cords prior to placement of concrete.

G. The ends of field cut conduits shall be reamed to remove rough edges. The ends of PVC conduits that are to be joined shall be coated with conduit cement for a length equal to the depth of the coupling or other fitting, to ensure a watertight connection.

3.5 PLACING CONCRETE

A. Provide notification to Caltrain a minimum of 24 hours prior to commencement of all concreting operations at each foundation.

B. General: Place concrete in compliance with the practices and recommendations of ACI 301, and as herein specified.

1. Deposit concrete such that no cold joints or planes of weakness are produced within the foundation. Perform concrete placing at such a rate that concrete being integrated with fresh concrete is still plastic. Deposit concrete as nearly as practicable to its final location to avoid segregation due to rehandling or flowing. Do not subject concrete to any procedure that will cause segregation. Place concrete in a compact, monolithic mass, using a method that prevents washing of concrete.

2. Use of vibrators is not required if concrete is placed in one lift, but multiple lifts require the use of a pencil vibrator to consolidate the top 3 to 6 inches of the previous lift.

3. Screed concrete to the proper level to avoid excessive skimming or grouting.

4. Do not use concrete that becomes nonplastic and unworkable, or does not meet the required quality control limits, or that has been contaminated by foreign materials. Do not use retempered concrete. Remove rejected concrete from the project site and dispose of it at the Contractor's expense, in accordance with the requirements of applicable regulatory agencies and project specifications.

5. Particular emphasis shall be given to the placement method type within a shift in the detailed description of pile construction procedure. Clearly identify and describe how to place concrete based on the method of installation.

6. A dry hole is defined as:

    a. A hole that 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.

    b. Has no more than 3 inches of water in the bottom of the drilled hole immediately before placing concrete.

7. Concrete Placed in a Dry Hole:

    a. Have a nominal slump of 4 to 6 inches for placement by hopper method:

        i. Using a trunk-equipped hopper or pump pipe inserted into the excavated hole as low as possible allowing concrete to fall freely into the pier in a vertical direction not more than 6-feet and not impacting the sides of the shaft or the reinforcement cage.

        ii. Vibrate concrete in the upper 15-feet when using hopper method. Emphasis should be given at the point where the concrete pour is momentarily halted.

    b. Have a nominal slump of 7 to 9 inches for placement by tremie method:

        i. Using a tremie tube, place the tip of the delivery tube within 6-inches of the bottom of the hole until 5-feet of concrete has been placed. Maintain the embedment of the tip at least 5-feet below the top surface of the concrete. Do not rapidly raise or lower the delivery tube.

        ii. Placing of concrete must be a continuous operation for each concrete placing operation at each pile.

        iii. Vibrating of concrete is not required.

        iv. The nominal penetration requirements of CSS Section 90 do not apply to concrete placed under tremie method.

8. Concrete Placed under Slurry:

    a. For all CIDH concrete piles except for piles constructed in dry holes or dewatered holes without the use of temporary casing to control groundwater or as in accordance with Section 2.12 of this specification. Placing of concrete must be a continuous operation for each concrete placing operation at each pile.

    b. Have a nominal slump of 7 to 9 inches for placement by tremie method:

        i. Using a tremie tube, place the tip of the delivery tube within 6-inches of the bottom of the hole until 5-feet of concrete has been placed. Maintain the embedment of the tip at least 5-feet below the top surface of the concrete. Do not rapidly raise or lower the delivery tube.

        ii. Vibrating of concrete is not required.

        iii. The nominal penetration requirements of CSS Section 90 do not apply to

concrete placed under tremie method.

9. To control caving, you may enlarge portions of the hole, backfill with concrete or slurry cement backfill, and re-drill the hole to the required diameter. Backfill material at enlarged piles must be chemically compatible with concrete and steel, be drillable, and have the necessary strength required for conditions.

C. Provide bracing to ensure stability of formwork. Strengthen all formwork which is liable to be overstressed by construction loads.

D. Application of Form Release Agent:

1. Apply form release agent on formwork in accordance with manufacturer's instructions. Apply prior to placing reinforcing steel, anchoring devices and to embedded items.

2. Do not apply form release agent where concrete surfaces are scheduled to receive special finishes or applied coverings which may be affected by the agent. Soak contact surfaces of untreated forms with clean water. Keep surfaces damp prior to placing concrete.

E. Inserts, Embedded Parts and Openings:

1. Provide formed openings where required for work bedded in or passing through concrete.

2. Coordinate work of other Sections in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, conduits, and other inserts as shown on the Contract Drawings.

3. Install accessories in accordance with manufacturer's instructions, level and plumb. Ensure items are not disturbed during concrete placement.

F. Concrete Mixing:

1. Concrete may be mixed at an approved batch plant or it may be transit-mixed. Batch plants shall comply with the requirements of ACI 304, with sufficient capacity to produce concrete of the qualities specified to meet the construction schedule or shall be in accordance with approved concrete mixing operations associated with mobile plant mixing. All plant facilities shall be subject to inspection and approval by Caltrain and shall comply with Section 03 30 00, Cast-In-Place Concrete.

G. Placing Concrete into Forms: Comply with Section 03 30 00, Cast-in-Place Concrete, as applicable.

H. Hot Weather Placement:

1. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305.

I. Cold Weather Placing:

1. Protect all concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures, in compliance with the requirements of ACI 306.

2. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators.

J. Ensure that all reinforcement, inserts, and embedded anchors are not disturbed during concrete placement.

1. Before placing concrete, clean reinforcement of dirt, oil, ice, or coatings which could reduce or destroy the bond with concrete.

2. Place, support, and secure reinforcement against movement and displacement, such that it does not deviate from final alignment or measurement.

3. Provide enough supports of the required strength to carry reinforcement. Do not place reinforcing bars more than 2 inches beyond the last leg of any continuous bar support.

4. Threads of anchor bolts shall be adequately protected prior to, during and after placement of the concrete.

K. Finish of Formed Surfaces (see also Section 03 35 00, Concrete Finishing):

1. Smooth Form Finish:

a. Provide as-cast smooth form finish for formed concrete surfaces that are to be exposed to view.

b. Produce smooth form finish by selecting form material to impart a smooth, hard, uniform texture and arranging them orderly and symmetrical with a minimum of seams. Repair and patch defective areas, with all fins or other projections completely removed and smoothed.

L. Form Removal:

1. Provide notification at least 24 hours prior to removing formwork.

2. Formwork supporting concrete, to include sides of foundations above ground level, may be removed after 24 hours of curing, provided that the concrete is not damaged during formwork removal.

3. All concrete damaged during formwork removal shall be repaired at Contractor's expense.

M. Withdrawal of Steel Casing:

1. Where temporary steel liners are used to support the excavation of drilled pier walls, withdraw the liners while the concrete is being placed. Remove the steel casing in a manner so that the lower edge of the steel casing will always remain a minimum of three feet below the surface of the concrete as poured to prevent water from entering the casing from the bottom or collapse of earth walls. Vibrate concrete during withdrawal of the steel casing.

N. Patching:

1. Patching Defective Areas:

a. Repair and patch defective areas with cement mortar immediately after removal of forms.

b. Cut out honeycomb, rock pockets, voids over 1/2-inch diameter, and holes left by tie rods and bolts, down to solid concrete but in no cased to a depth of less than one inch. Make edges of cuts perpendicular to the concrete surface. Before placing the cement mortar, thoroughly clean, dampen with water and brush-coat the area to be patched with neat cement grout. Approved proprietary patching compounds may be used.

c. For surfaces exposed to public view, the patching mortar shall match the color of the surrounding concrete. Provide test areas at inconspicuous locations to verify mixture and color match before proceeding with the patching. Compact mortar in place and strike off slightly higher than the surrounding surface.

d. Repair methods not specified above may be used, subject to approval.

O. Schedule of Formed Surfaces:

1. Smooth surface finish for all OCS structure foundations.

3.6 FIELD QUALITY CONTROL

A. Field inspection will be performed by Caltrain and/or their representatives.

B. Quality Control testing during construction shall be performed as follows:

1. Sampling Fresh Concrete: ASTM C172, except as modified for slump, to comply with this specification.

2. Slump: ASTM C143; one test for each concrete load at point of discharge; and one for each set of compressive strength specimens.

3. Compression Test Specimens: ASTM C31.

4. Concrete Temperature: Test daily when air temperature is 40° F and below, and when 80° F and above; and each time a set of compressive test specimens is made.

5. Compressive Strength Tests: ASTM C39.

6. Testing laboratory shall report tests results in writing to Caltrain. Reports of compressive strength tests will contain the project identification name and number, date of concrete placement, name of Contractor, name of concrete testing service, concrete type and class, pole number(s) of foundation(s) and location(s) of downguys poured with each batch, design compressive strength at 28 days, concrete mix proportions and materials: compressive breaking strength and type of break for both 7-day test and 28 day test.

C. Additional Tests:

1. The testing services shall make additional tests of in-place concrete when test results indicate the specified concrete strengths and other characteristics have not been attained in the structure. The testing service shall conduct tests to determine the strength and other characteristics of in-place concrete by compression tests on cored cylinders complying with ASTM C42, or by load testing specified in ACI 318, or other acceptable non-destructive testing methods, as directed. The Contractor shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified.

D. Evaluation of Quality Control Tests:

1. Do not use concrete delivered to the final point of placement which has slump outside the specified values.

2. Compressive strength tests for laboratory-cured cylinders will be considered satisfactory if the averages of all sets of three consecutive compressive strength tests results are equal to or exceed the 28-day design compressive strength of the type or class of concrete; and no individual strength test falls below the required compressive strength by more than 500 psi.

3. If the compressive strength tests fail to meet the minimum requirements specified, the concrete represented by such tests will be considered deficient in strength and rejected for inclusion in the work.

E. Foundation Grounding System Tests:

1. Perform electrical resistance testing of the OCS foundation grounding system. Any incorrect grounding arrangements shall be repaired and corrected.

3.7 ADJUSTING AND CLEANING

A. Clean forms to remove foreign matter as installation proceeds.

B. Do not use water to clean out completed forms unless formwork and construction proceed within heated enclosure. Use compressed air or other methods for which an approval has been received to remove foreign matter.

C. Concrete not conforming to required levels and lines, details, and elevations shall be replaced at no cost.

3.8 PROTECTION

A. Protect finished work until final acceptance. Special precautions shall be employed to assure that above ground portions of completed foundations (including the anchor bolts, anchor rods and concrete finish) are not struck or damaged by other equipment working adjacent to the foundations, including equipment employed by sub-contractors and other Caltrain Contractors (such as earthmoving equipment, dump trucks, ballast delivery trucks, rail placement equipment, etc.). Submit proposed method of protecting the OCS foundations review prior to the construction of any OCS foundations.

B. Immediately after placement, protect exposed concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

1. Protect freshly placed concrete from premature drying and at temperatures at or above 80^{o} F and at or below 40^{o} F and maintain without drying at a relatively constant temperature for the period necessary for hydration of the cement and proper hardening of the concrete.

2. Begin final curing procedures for exposed concrete immediately following hydration of the cement and proper hardening and before the concrete has dried. Continue final curing for at least 7 days and in accordance with ACI 301. Avoid rapid drying at the end of the final curing period.

C. Temperature of Concrete During Curing:

1. When the atmospheric temperature is 40° F or below, maintain a homogeneous concrete temperature between 50° F and 70° F continuously throughout the final curing period. When necessary, make arrangement before concrete placing for heating, covering, insulation or housing as required to maintain the specified temperature and moisture conditions continuously for the concrete curing period. Provide cold weather protections complying with the requirements of ACI 306.

2. When the atmospheric temperature is 80° F and above, or during other climatic conditions which will cause too rapid drying of the exposed concrete, plan before the start of concrete placing for the installation of wind breaks or shading, and for fog spraying, wet sprinkling, or moisture-retaining covering. Protect the exposed concrete continuously for the concrete curing period. Provide hot weather protection complying with the requirements of ACI 305.

3. Maintain concrete temperature as uniformly as possible and protect from rapid atmospheric temperature changes. Avoid temperature changes in concrete which exceed 5° F in one hour and 50° F in a 24-hour period.

D. Protection from Mechanical Injury:

During the curing period, protect concrete from damaging mechanical disturbances, including load stresses, heavy shock, excessive vibration, and from damage caused by rain or flowing water. Protect all exposed finished concrete surfaces from damage by subsequent construction operations.

END OF SECTION

SECTION 34 30 36
METAL FABRICATION FOR OCS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for general metal fabrication, including galvanizing, for use on the Overhead Contact System (OCS).

1.2 REFERENCE STANDARDS

A. American Society for Testing Materials International (ASTM):

1. A27, Specification for Steel Castings, Carbon, for General Application.

2. A36/A36M-19, Specification for Carbon Structural Steel.

3. A48, Specification for Gray Iron Castings.

4. A53, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

5. A109, Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled.

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

7. A153, Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

8. A193, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

9. A194, Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

10. A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.

11. A488, Standard Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel.

12. A500, Specification for Cold Formed Welded and Seemless Carbon Steel Structure Tubing.

13. A536, Specifications for Ductile Iron Castings.

14. A572, Specification for High Strength, Low-Alloy Columbium-Vandadium Structural Steel.

15. A653, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galv-annealed) by the Hot-Dip Process.

16. A780, Practice for Repair of Damaged Hot-Dip Galvanized Coatings.

17. A992, Specification for Structural Steel Shapes.

18. F3125 Grade A325, Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

B. American Welding Society (AWS):

1. D1.1, Structural Welding Code Steel

C. Department of Defense (DOD):

1. DOD-P-15328, Primer (Wash), Pretreatment (Formula No. 117 for Metals) (Metric).

D. Federal Specifications (FS)

1. QQ-F-461, Floor Plate, Steel, Rolled.

E. Steel Structures Painting Council (SSPC):

1. SSPC-SP 1, Solvent Cleaning.

2. SSPC-SP 3, Power Tool Cleaning.

3. SSPC-PA 1, Shop, Field & Maintenance Painting.

4. SSPC-Paint 20, Zinc-Rich Primers (Type I – Inorganic & Type II – Organic).

1.3 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Submit shop drawings to Caltrain for review and approval 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.

C. Submit manufacturers' product data. Include application instructions for galvanizing repair product.

D. Submit the following welding qualifications. If personnel are AISC certified Fabricators, then records are not necessary. However, records shall be maintained and made available if an audit is requested.

1. Welders Procedure Spec (WPS)

2. Procedure Qualification Record (PQR)

3. Welder Qualification Test Record (WQTR)

E. Submit AISC certification documents that indicate fabricator is an AISC certified fabricator.

1.4 DELIVERABLES

A. Welders' Certificates: Submit certification of personnel employed on the work to satisfy the requirements of Part 4 of AWS D1.1.

1.5 QUALITY ASSURANCE

A. Welding including shielded arc process shall conform to the requirements in AWS D1.1 Structural Welding Code.

B. Unless AISC Certified Fabricator, a submission under 1.3, WPS, PQR, WQTR is needed.

PART 2 - PRODUCTS

2.1 STEEL

A. Shapes: ASTM A992 - Grade 50 as applicable.

B. Plates and Bars: ASTM A572 – Grade 50 as applicable.

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. Castings: ASTM A27 or A48, as indicated.

G. Ductile Iron: ASTM A536

2.2 FASTENERS

A. Steel Bolts, Stud Bolts, Nuts, Shear Studs and Threaded Rods: ASTM A307 or ASTM A193 Grade B, unless otherwise noted.

B. High Strength Steel Bolts with Nuts: ASTM F3125 Grade A325, unless otherwise noted.

C. Threaded Inserts: Furnish unit-type inserts of the type and size required, of cast iron, malleable iron, stainless steel or hot-dip zinc -coated steel, unless otherwise noted.

2.3 MISCELLANEOUS MATERIALS

A. Use E7018 low hydrogen electrodes for shapes, plates, and bars.

B. Primer Pretreatment: DOD-P-15328.

C. Corrosion-Inhibitive Metal Primer: SSPC-Paint 20, except for prime coat requirements for painted OCS poles refer to Section 34 30 46 Painting OCS Poles.

D. Hot Process Field Galvanizing (for repairs): Galv, Galvalloy, Galvweldalloy, or equal.

2.4 CHECKERED SAFETY PLATE

A. FS QQ-F-461, Class 1, flat black, standard 4-way raised pattern.

2.5 IRON CASTINGS

A. Gray: ASTM A48, Class 35B, unless otherwise noted.

2.6 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 shop drawings for which Caltrain has reviewed; with straight lines, square corners or smooth bends; free from twists, kinks, warps, dents, and other imperfections. Straighten work bent by shearing or punching.

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 while in service in severe conditions (including high winds and excessive precipitation or heat). 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. Fabricate flanges for posts and standoff from plates of thickness indicated on the Contract Drawings.

F. Grind off excess metal and make smooth surface welds which will be exposed to view.

2.7 GALVANIZING

A. Where galvanizing is required, 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 products after fabrication (including shearing, punching, bending, forming, or welding) in accordance with ASTM A123 and ASTM A153 as required.

C. The weight of zinc coating shall be not less than 2.0 ounces per square foot of surface area.

2.8 SHOP FINISHING

A. Nongalvanized Metalwork: Shop paint ferrous metal which is not 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install metal fabrications with installation accessories furnished by fabricator as required for complete installation.

B. Install in accordance with shop drawings for which Caltrain has reviewed, 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. Keep field joints to a minimum and concealed. Make field joints strong, rigid, watertight and flush with hairline fit. Grind sharp corners smooth.

D. Grind off excess metal and make smooth surface welds which will be exposed to view.

E. After installation, retouch damaged primed surfaces; leave ready for field painting. Touch up galvanized surfaces using hot process field galvanizing product.

END OF SECTION

SECTION 34 30 39

OCS METAL POLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for the supply and installation of OCS poles and small part steelwork for the Overhead Contact System (OCS) as shown on the Contract Drawings and specified herein.

B. The poles shall consist of wide flange, square tube (HSS). and tapered tubular steel types. All poles shall conform to the type and size requirements shown on the Contract Drawings.

C. The OCS poles which support the balance weight anchor assembly shall be wide flange poles or non-tapered round, and conform to the type and size requirements shown on the Contract Drawings.

D. All round pole shafts shall be smooth (not multi-faceted) as indicated on the Contract Drawings.

E. OCS poles and small parts steelwork to be erected for the OCS shall be designed, furnished and installed.

F. All poles shall be galvanized regardless of finish treatments.

G. The Contractor shall coordinate with the local municipal authority and paint and treat OCS poles as requested by that authority, in accordance with this Section and Section 34 30 46 Painting OCS Poles. All poles are to be galvanized regardless of finish treatments.

1.2 REFERENCE STANDARDS

A. Pertinent provisions of the following latest edition standards shall apply to the work of this Section, except as they may be modified herein, and are hereby made a part of this Specification to the extent required:

1. American Society for Testing and Materials (ASTM)

    a. A36/A36M-05, Specification for Carbon Structural Steel.

    b. A53, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.

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

    d. A143, Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedures for Detecting Embrittlement.

    e. A153, Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.

    f. A283, Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.

g. A354, Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners.

h. A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.

i. A500, Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing.

j. A563, Specification for Carbon and Alloy Steel Nuts.

k. A572, Specification for High-Strength, Low-Alloy Columbium-Vanadium Structural Steel.

l. A595, Specification for Steel Tubes, Low-Carbon, or High-Strength Low-Alloy, Tapered for Structural Use.

m. A607, Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Columbium or Vanadium, or Both, Hot-Rolled and Cold-Rolled.

n. A992, Specification for Structural Steel Shapes.

o. E1316, Standard Terminology for Nondestructive Examinations.

p. B6, Specification for Zinc.

q. E709, Standard Guide for Magnetic Particle Testing.

r. F3125 GRADE A325, Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

s. F3125 GRADE A490, Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

t. F436, Specification for Hardened Steel Washers.

u. F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

2. American Institute of Steel Construction (AISC)

a. Specifications for Structural Joints Using ASTM F3125 Grade A325 or A490 Bolts.

b. Specification for Structural Steel Erection.

3. American Welding Society (AWS)

a. D1.1, Structural Welding Code.

4. Weathering Steel is not permitted on the corridor because of the marine, salt-fog environment and the instability of protective rust layer under such conditions. See paragraph 2.1.D, this section, for galvanizing of OCS poles and small steel parts.

1.3 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Submit the manufacturer's specifications and installation instructions for Caltrain review for all components in this Section. Additionally, submit specifications and installation instructions to Caltrain for records purposes.

C. Submit Shop Drawings for review by Caltrain showing details and dimensions of all pole types and small parts steel, together with complete specifications of materials and components including supporting calculations.

1. Prepare Shop Drawings under seal of a Professional Structural or Civil Engineer registered in the State of California. Shop drawings to be drawn to scale and indicate all fittings, holes, and accessories, with locations, sizes and types of all welds.

D. Submit certificates of compliance or certified laboratory test reports demonstrating compliance of all raw materials and fabricated products prior to fabrication.

E. Furnish a certification verifying that the materials have been designed, manufactured, inspected and tested in accordance with the applicable portion of the reference standards and these specifications.

F. Furnish copies of reports of all factory tests as required by these specifications and referenced standards.

G. On shop drawings, indicate welded connections using standard AWS welding symbols. Indicate net weld lengths, and sizes.

H. Submit an authentic sample of any component as indicated on shop drawing reviews, when so requested, or as required in the Specifications. All samples shall be identified with a tag label of suitable material, wired to the sample.

I. For OCS poles in station areas, submit all specifications, installation instructions, shop drawings, certificates, test reports, samples, and other submittals to Caltrain for review and transmittal to the local municipal authority

J. Submit welding procedures in accordance with AWS D1.1.

K. Submit qualifications of welders, welding operators and tackers in accordance with AWS D1.1.

1.4 QUALITY ASSURANCE

A. Perform the Work included in this Section in strict accordance with the requirements of Section 01400, Quality Control and Assurance.

B. Qualifications for Welding Work

1. Quality of welding processes and welding operations shall be in accordance with AWS D1.1 and Quality Plan.

2. Provide certifications that welders employed have satisfactorily passed AWS qualification tests within the previous 12 months.

a. Provide re-certification and retesting of welders when necessary.

C. Source Quality Control

1. Material and fabrication procedures are subject to inspection and tests in the mill, shop, and field. These inspections and tests shall not relieve the responsibility for providing materials and fabrication procedures that are in compliance with the requirements.

D. Pre-assemble components in the shop, to minimize field splicing and assembly of units at the project site. Disassemble units only to the extent necessary for shipping and handling. Clearly mark components, with permanent markings, for easy assembly at site of installation.

E. The chemical compositions and appropriate mechanical properties shall be determined for all materials used by obtaining manufacturer's certificates of compliance.

F. Weld Testing

1. Provide an AWS Certified Welding Inspector, employed by the fabricator, to perform specified fabrication and verification inspection of welding procedures and personnel, and to perform weld tests as specified herein. Submit qualifications of Welding Inspector to Caltrain for review and approval.

2. Visually inspect of all welds in accordance with the AWS Code.

3. Perform weld testing on a sample number of poles selected at random, comprising a minimum of 5% of the total number of poles.

4. Equipment, procedures and personnel for weld testing, and test reports, shall conform to the requirements of AWS D1.1, Section 8, Inspection.

5. Weld testing consist of:

a. Ultrasonic testing conforming to the requirements of AWS D1.1, Section 8;

b. Magnetic particle testing conforming to the requirements of ASTM E709.

6. Test all poles selected for testing by the ultrasonic and magnetic particle methods.

7. Perform ultrasonic testing on complete penetration welds between the pole shaft and pole base, and on any circumferential welds in the pole shaft, for each pole being tested. Perform magnetic particle testing on all other welds including longitudinal seam welds, welds at handholes, etc.

8. For each tested pole that is found to be unacceptable, weld testing shall be performed on a further sample of two (2) poles of each size, selected at random.

9. Results of weld testing are deemed acceptable or unacceptable in accordance with AWS D1.1, Section 8.

10. Repair unacceptable welds and retest.

G. Test structural steel materials for base plates and pole shafts for impact toughness in accordance with the Charpy V-notch test as specified in ASTM A370. The minimum energy value shall be 15 ft.-lbs. at +40° F.

1.5 DELIVERY, STORAGE AND HANDLING

A. Ensure that all poles and small part steelwork materials furnished are suitably packaged and protected against damage during delivery, transportation and storage.

B. Store all poles and small part steelwork in accordance with the manufacturer's instructions, to ensure that all material is protected from damage or misuse prior to or during installation.

C. Repair or replace any damage to the poles and small part steelwork. All repairs and replacements shall be accomplished in accordance with the manufacturer's instructions.

D. Prepare poles and accessories and ship in a manner to prevent damage to the painted or weathering surfaces. Repair all damage to the exterior surface and coatings, in accordance with the manufacturer's instructions.

E. Inspection of OCS poles and small parts steel components may be made on a regular basis prior to their erection. OCS poles and small parts steelwork shall not be stored in direct contact with the ground. All steel, galvanizing and painted coatings which become soiled or damaged by improper storage methods shall be repaired and returned to a like-new condition. The means and methods of security and protection for all stored items shall be approved by Caltrain.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide poles that conform to AISC Specification, Code of Standard Practice for Steel Buildings and Bridges, and specification for Design, Fabrication and Erection of Structural Steel for Buildings.

1. Conform to ASTM A143 to prevent embrittlement of the steel.

2. Design steel and connections to withstand 85 MPH winds, including overload factors (and 110 mph for structure failure checking).

B. Retain for record purposes all certified test reports required to verify conformance to minimum yield strength. Such test reports may be the mill test reports for the as-received steel. When the as-received steel has lower yield strength than required, provide supportive test data, assuring that its method of cold forming will consistently increase the tensile properties of the steel to meet the specified minimum yield strength. Such supportive test data shall include tensile properties of the steel both before and after cold forming for specific heats and thickness.

C. Furnish base plate assemblies with finished smooth surfaces. Provide neatly rounded corners, unless otherwise indicated on the Contract Drawings.

D. Hot-dip galvanize all OCS poles and small steel parts, including their fittings and accessories after fabrication in accordance with ASTM A123 and A153, respectively. Galvanize each pole and part for its entire length in a single dipping operation. Successive dipping of poles will not be permitted.

E. Pole shafts shall be straight with a permissible variation under no-load conditions not to exceed 1 inch measured from base to top.

F. Demonstrate the deflection of each type of tubular steel and square tubular (HSS) pole furnished. The demonstration shall be in the form of a factory test performed at the place of manufacturer.

Perform non-destructive at a place and time agreed upon. Develop a test procedure for testing of the poles. Include as part of the test, method of application of loads, recording devices, calibration of devices, and any other pertinent information. Conduct tests on a rigid foundation that resists all translation and rotation about any axis.

1. Subject poles to the loads that will result in maximum pole deflection as defined in manufacturer's written literature. Apply the load 18 inches from the top of the pole and at right angles to its longitudinal axis. Upon removal of the load the pole at the point of load shall not show a permanent set exceeding 1/2 inch.

2. Conduct tests on no more than 5 percent of the poles in any lot of 20 or more with only one pole from any lot under 20. A lot is defined as the number of poles of any one size on a purchase order.

3. If any pole fails the tests in any lot, an additional 5% of the poles from the same lot shall be tested. If any pole fails again, the entire lot will be rejected. As an option, each pole in the lot in question may be tested for acceptance.

4. Provide at least 15 days notice prior to performing any tests.

2.2 STANDARD TAPERED TUBULAR PLAIN POLES

A. Provide tapered tubular, hot-dip galvanized steel poles, complete with base plates, hand holes, fittings, and accessories as indicated on the Contract Drawings. Conform to the requirements indicated herein and as specified in Article 2.1.

B. Fabricate the poles from sheet steel of weld-able grade conforming to ASTM A595, Grade A, with the minimum yield strength of 55 ksi. Gauge of steel shall be as indicated on the Contract Drawings. Alternate designs maybe submitted for approval.

C. Pole shafts shall be fabricated of full-length sheets. Each section shall be fabricated from not more than 2 plies of sheet steel. Where 2 plies are used, longitudinal welded seams shall be directly opposite one another. When the sections are butt-welded together, the longitudinal welded seams on the adjacent section shall be placed to form continuous straight seams from base to top of the pole shaft.

D. Where two-ply poles are used, the laminated pole thickness and moment of inertia shall be adjusted to compensate for the possible increase in deflections due to lamination effect.

E. All welds shall be continuous.

F. Supply poles with pole caps, cap mounting screws and all miscellaneous hardware required to complete the poles as shown on the Contract Drawings. Pole caps shall be galvanized pressed steel, fitted with three tamper-resistant stainless steel set screws. A manufacturer's standard pole cap design such as pressed fit cap with set screw will be acceptable subject to Caltrain's approval.

G. All hardware and fastening devices including screws, nuts and bolts shall be stainless steel materials and tamper-resistant to prevent unauthorized tampering and/or disassembly of the completed pole installation.

H. Fabricate base plates from structural steel conforming to ASTM A572, Grade 50. The minimum yield stress capacity of the base plate steel shall be not less than 90 percent of the yield stress capacity of the pole shaft steel.

I. Welding electrodes and fluxes shall conform to the applicable requirements of AWS D1.1.

J. Zinc used for hot-dip galvanizing shall conform to ASTM B6.

K. Pole shafts, fittings, and accessories shall be fabricated to the tolerances conforming to the AISC Specifications, except as specified herein:

1. Pole tube base outside diameter to within 1/16 inch of the design diameter.

2. Pole wall thickness to be within plus 10 percent and minus 5 percent of the design thickness.

3. Pole taper to be a uniform rate of 0.14 in/ft, with a tolerance of +/- 0.02 inches, as indicated on the Contract Drawings.

4. Pole length to be plus two inches and minus zero inches.

L. Drill the inner ply of multiple-ply poles to provide drain relief holes for use during galvanizing. Arrange holes so that the strength of the pole is not reduced.

M. Attach a manufacturer' pole identification sign to each pole immediately after fabrication include, pole type, manufacture, date of manufacture. Loading ratings.

N. Identify pole type using one-half inch high die-stamped character on pole shaft and underside of base plate.

2.3 TUBULAR STEEL POLES HSS AND ROUND

A. Use Tubular Steel Poles at locations indicated on the Contract Drawings. Conform to the requirements indicated herein and as specified in article 2.1.

B. Fabricate HSS square and rectangular poles from ASTM A500, Grade C Steel, minimum yield stress 50 ksi. Fabricate round non-tapered from ASTM A500 Grade C Steel, minimum yield stress 46 ksi. Hot-Dip Galvanized per ASTM A123.

C. Fabricate base plates from structural steel conforming to ASTM A572, Grade 50. The minimum yield stress capacity of the base plate steel shall be not less than 90 percent of the yield stress capacity of the pole shaft steel.

D. Welding electrodes and fluxes shall conform to the applicable requirements of AWS D1.1.

E. Zinc used for hot-dip galvanizing shall conform to ASTM B6.

2.4 WIDE FLANGE POLES

A. Wide Flange Poles are to be utilized in open route conditions at locations indicated on the Contract Drawings. Conform to the requirements indicated herein and as specified in article 2.1.

B. Fabricate Wide Flange Poles from ASTM A992 Grade 50 ksi steel; Hot-Dip Galvanized per ASTM A123.

C. Fabricate base plates from structural steel conforming to ASTM A572, Grade 50. The minimum yield stress capacity of the base plate steel shall be not less than 90 percent of the yield stress capacity of the pole shaft steel.

D. Welding electrodes and fluxes shall conform to the applicable requirements of AWS D1.1.

E. Zinc used for hot-dip galvanizing shall conform to ASTM B6.

PART 3 - EXECUTION

3.1 DELIVERY

A. Deliver all small parts steel and OCS poles with integral base plates complete with associated fittings and accessories, properly packed and protected against damage and loss of parts.

3.2 INSTALLATION/ERECTION

A. Erect structural steel in accordance with AISC Specification for structural steel erection or in accordance with manufacturer's recommended instructions.

B. The pole rake to be determined such that the pole shafts appear to be vertical when the static OCS loads are applied at an ambient temperature of 80 deg F. Anchor base steel poles shall be raked by means of nuts and washers, with one nut and washer above, and with one nut and washer below, the pole base plate. After loading with wires and final tensioning, adjust down guys, where applicable, to ensure that poles are plumb.

1. Do not grout the space between the base plate and the foundation, unless otherwise indicated on the Contract Drawings. After the poles have been erected, install a second jam nut on top of the first nut above the baseplate so that the nuts cannot become loose or easily removed.

2. All steel poles installed within station platforms must be electrically bonded only to the foundation ground cable and rod or counterpoise wire, as shown on the Contract Drawings.

3. Set poles (unloaded) not earlier than seven days after foundations are installed. Do not load the OCS poles to the design requirements earlier than 28 days after foundations are installed, without approval by Caltrain.

4. If pole bases are to be recessed below the platform or sidewalk level, the platform or sidewalk shall be restored with like materials to be flush with the adjacent surface. Do not restore platforms and sidewalks until after inspection of the pole installation, and after the pole has been loaded and OCS wires tensioned.

5. Install the tubular poles so that the handhole (if any) is located on the side of the pole, away from the rail, street or the normal direction of approaching vehicular traffic. Face handholes on center poles located between tracks along the centerline of the trackway.

6. Within 5 working days after installation, the poles shall be equipped with and display a temporary structure number. During the registration phase, a permanent structure number shall be installed in accordance with the Contract Drawings.

7. Ground and bond all metal poles to the foundation as indicated on the Contract Drawings.

8. Pole caps shall be installed on all tubular poles prior to setting of the poles.

C. Pole Installation Acceptance

1. As part of the OCS acceptance procedures, measure and record the face-of-pole to centerline-of-track distances at rail level in accordance with the Acceptance Measurements form. Submit the Acceptance Measurements form for Caltrain review and approval. The pole-to-track distance is defined as the as-built horizontal clearance, centerline of track to closest pole face, for each track served.

END OF SECTION

SECTION 34 30 43

OCS SIGNAGE

PART 1 - GENERAL

1.1 DESCRIPTION

A. The Section includes specifications for the supply and installation of OCS pole identification and safety signs for the Overhead Contact System (OCS) including signal bridges, overhead bridges, and fences in electrified territory, as shown on the Contract Drawings and specified herein.

1.2 REFERENCE STANDARDS

None

1.3 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Submit detailed lists of signs by group or type for Caltrain review and approval prior to commencing any work on a group or type of signs.

C. Submit one (1) sample of pole identification signs prior to final order and fabrication. Submitted signs will not be returned.

1.4 QUALITY ASSURANCE

A. Perform all Work included in this Section in strict accordance with the requirements of Section 01400, Quality Control and Assurance.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all signs and materials in such a manner to avoid damage.

1.6 WARRANTY

A. Manufacture all signs for outdoor use. Demonstrate that no appreciable discoloration, cracking, blistering or dimensional change will occur for a period of not less than 10 years.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide OCS Pole identification signs conforming to the material type and size shown on the Contract Drawings.

2.2 FABRICATION

A. All letters and numbers shall be on the front (single-sided) only.

B. Prepare all painted and adhering surfaces in accordance with the decal manufacturer's recommendations and made free from dirt, oil, and grease or other substances that prevent bonding.

C. The pole identification numbers shall be of the size shown on the Contract Drawings. Number in accordance with pole numbers or pole IDs shown on the OCS Layout Plans.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surfaces to which signs and decals shall be attached shall be free of dirt or foreign objects.

3.2 INSTALLATION / APPLICATION / ERECTION

A. Place OCS pole identification and safety signs at signal bridges, overhead bridges and fences as indicated on the Contract Drawings.

B. Install pole identification numbers to the side of the pole facing the normal direction of traffic (so it can be read by Train Operator).

END OF SECTION

SECTION 34 30 46

PAINTING OCS POLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for the supply and painting of hot-dipped galvanized OCS poles, structures and small part steel attachments, where indicated on the Contract Drawings and in other Sections.

B. Coordinate with the local municipal authority, and paint and treat OCS poles in station areas, and in specified painted pole mitigation areas, as requested by that authority, in accordance with this Section and Section 34 30 39, OCS Metal Poles. All poles are to be galvanized regardless of finish treatments.

1.2 SYSTEM DESCRIPTION

A. Painted OCS poles and attachments as supplied from the manufacturer in a finished condition and/or items requiring field painting shall conform to these Specifications.

1.3 REFERENCE STANDARDS

A. The following standards shall apply and are made a part of this Specification.

1. American National Standards Institute (ANSI):

a. Z55.1, Standard Gray Finishes for Industrial Apparatus and Equipment.

1.4 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Submit color samples.

C. Submit paint data.

D. Submit paint shop application methods for all poles and steelwork, including preparation methods, application procedures and special curing practices used.

E. Submit paint manufacturer certification that selected paint is suitable for the intended application.

F. Submit all color samples, paint data, application methods, and other submittals to the local municipal authority for OCS poles in station areas and in specified painted pole mitigation areas.

G. Submit warranty documentation complying with Section 1.6 WARRANTY.

H. Submit current SSPC certification for the painter.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store paint and painting tools per manufacturer's recommendation. Store and handle all painted

equipment and material so as to not damage the finished surface.

B. All unused paint and solvents shall be disposed of in an approved disposal site.

1.6 WARRANTY

A. Guarantee the finish coating for a minimum of 10 years, with no major paint peeling, blistering, cracking or surface corrosion occurring within that period.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. The term PAINT as used herein, includes powder coatings, emulsions, enamels, varnishes, paints and other protective sealers, whether used as a prime, intermediate or finish coat.

B. Paint materials furnished shall be standard products of manufacturers regularly engaged in the protection of materials specified.

C. The types of paint for use on hot-dipped galvanized OCS poles are as follows:

1. Prime Coat – Epoxy Powder

2. Intermediate Coating – Polymer Powder

3. Finish Coating – Polymer Powder

D. Contractor shall be responsible for proper selection and application of all coatings of paint.

2.2 FABRICATION

A. OCS poles shall be hot-dipped galvanized in accordance with Section 34 30 39, OCS Metal Poles, before painting.

PART 3 - EXECUTION

3.1 TESTING AND INSPECTION

A. All paint and its application shall be inspected for conformity with manufacturer's recommendations and subject to Caltrain's approval.

3.2 APPLICATION

A. Hot-dip galvanized OCS poles and accessories.

B. OCS poles shall receive a surface treatment, prime coat, intermediate coat and finish factory paint coating as a finished treatment.

C. Methods of surface cleaning and thicknesses of coat painting applied shall be per manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

A. All painting activities shall be in accordance with these Specifications and are subject to inspection

at any time.

B. Remove all paint which is unacceptable, or repair in accordance with the paint manufacturer's instructions.

C. Repair all poles and steelwork which have paint damage due to mishandling, poor erection and/or storage practices. Accomplish all paint repairs in accordance with the paint manufacturer's instructions.

END OF SECTION

SECTION 34 30 49

OCS GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies furnishing, installing, and testing complete grounding and bonding systems for all OCS structures, static wires and shunt wires as shown on the Contract Drawings including, but not limited to: OCS poles and structures, disconnect switch ground mats, and OCS surge arresters.

B. The Contractor shall maintain the integrity of the existing structures' grounding and bonding systems during all phases of demolition and construction until the new system is in place. Contractor shall submit detailed grounding and bonding plans for all proposed permanent configurations to Caltrain.

C. For grounding and bonding of all other system elements not included in this specification, see section 26 05 26, Systemwide Grounding and Bonding.

1.2 QUALITY ASSURANCE

A. The following Codes, Regulations, Reference Standards and Specifications apply to the work included in this Section:

1. Aluminum Association (AA)

2. American Society for Testing and Materials (ASTM International)

3. Institute of Electrical and Electronics Engineers (IEEE)

4. National Fire Protection Association (NFPA)

5. National Electric Safety Code (NESC)

6. Underwriter's Laboratories (UL)

B. Source Quality Control: Each item UL-Listed.

1.3 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Submit the following to Caltrain for review and approval:

1. Shop Drawings:

a. Locations of ground rods, connectors, cables, and details of connections and terminations.

b. Manufacturers catalog data for all proposed materials with installation recommendations.

C. Certification: Certified test reports verifying that ground resistance, when grounding and bonding is installed to the ground rods, does not exceed the values specified in Article 3.2.

1.4 REFERENCES

A. Aluminum Association (AA)

1. 90, Aluminum Standards and Data.

B. American Society for Testing and Materials (ASTM)

1. A666, Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

2. B8, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

3. B187, Specification for Copper, Bus Bar, Rods and Shapes and General Purpose Rod, Bar, and Shapes.

4. B231, Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors.

C. Institute of Electrical and Electronics Engineers (IEEE)

1. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

D. National Fire Protection Association (NFPA)

1. National Electric Code (NEC)

E. Underwriter's Laboratories (UL)

1. 467, Safety Grounding and Bonding Equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Grounding and bonding equipment shall comply with UL 467.

B. Ground Rods: Copper clad steel or other material as shown on the Contract Drawings. Unless otherwise indicated minimum dimensions shall be ¾ inch diameter by 10 feet long. Sectional or multiple ground rods shall be used where required to attain the ground resistances shown on the drawings and specified herein.

C. Grounding Conductor:

1. Grounding Conductors

a. Bare or covered aluminum or copper conductor as shown on the Contract Drawings.

b. Sizes: In accordance with NEC Table 250-94.

D. Terminal Lugs:

1. For 4/0 AWG and Smaller Conductors: Copper and aluminum compression terminal lugs.

2. For 250 MCM and Larger: Long barrel, copper, double-compression terminal lugs.

E. Ground Connectors:

1. O-Z Gedney, Type KG or equal.

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

3. Exothermic Welds: Size and type per manufacturer's recommendations.

F. Jumpers:

1. Aluminum or copper braided or leaf-type flexible jumper, size as shown on the Contract Drawings.

PART 3 - EXECUTION

3.1 GROUNDING

A. Ground Connections to OCS Poles:

1. Install a ground rod in each OCS foundation with size and location in accordance with the Contract Drawings.

2. Install a bonding conductor between the ground rod, anchor bolts, and rebar cage. For configuration and number of connections see the Contract Drawings.

3. After pole installation, provide a ground wire connection between the foundation ground rod and the pole as indicated on the Contract Drawings.

3.2 FIELD QUALITY CONTROL

A. Test ground resistance of each ground grid after installation and each subsystem independently or when connected to the system ground, as appropriate, in accordance with the test plan and specification Section 34 30 86, OCS Testing.

B. Ground resistance shall not exceed the following:

1.	Pole Mounted Disconnect Switch Ground Mats	Five (5) ohms
2.	OCS Surge Arresters	Five (5) ohms
3.	OCS Poles	Twenty-five (25) ohms
4.	Shunt Wire	Five (5) ohms

C. Record ground resistance test results at each location, in table form, for review by Caltrain.

D. In the presence of Caltrain and prior to backfilling ground rod hole, test the grounding installation to demonstrate that the total ground resistance does not exceed the required values.

E. To meet maximum allowable ground resistance requirements, install additional ground rods or counterpoise as necessary.

F. If any of the test results exceed the maximum resistance, install additional ground rods and retest.

G. Test metallic conduit and raceways, equipment enclosures, metallic cable troughs, fences, hand railings, metallic structures, and light standards for continuity to subsystem grounding.

H. Prepare and submit certifications as specified to Caltrain.

END OF SECTION

SECTION 34 30 51

OCS SUPPORTING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for the supply and installation of the following types of OCS support and registration assemblies for the Overhead Contact System, as shown on the Contract Drawings and specified herein.

1. Pull-Off Single-Track Cantilevers
2. Push-Off Single-Track Cantilevers
3. Non-Riding and Support-Only Single-Track Cantilevers
4. Twin Cantilevers
5. Two-Track Cantilevers
6. Multi-Track Headspan Support and Registration Assemblies
7. Multi-Track Cross-Span Support and Registration Assemblies
8. Wire Pull-Off and Backbone Registration Assemblies
9. Aerial Head Guy Supports
10. Overhead Bridge Support Assemblies
11. Down Guy Assemblies
12. Contact Wire Bridges
13. Section Insulators

B. Furnish and install cantilever assemblies for supporting the overhead wires. The cantilevers shall be installed as shown on the Contract Drawings.

C. Furnish and install all applicable headspan and cross-span assemblies for supporting the overhead wires. The headspans and cross-spans shall be installed as shown on the Contract Drawings.

D. Furnish and install messenger, contact, cross-span, aerial head guy, backbone, pull-offs, bridge support and registration assemblies as shown on the Contract Drawings.

1.2 REFERENCES

A. Codes and Standards: Pertinent provisions of the following listed standards shall apply, except as they may be modified herein, and are hereby made a part of this Section.

1. American Society for Testing and Materials (ASTM):

a. A572, Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

b. A53, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

c. A47, Specification for Ferritic Malleable Iron Castings.

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

e. A153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

f. A484, Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings.

g. A530, Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.

h. A992, Specification for Structural Steel Shapes.

i. B150, Specification for Aluminum Bronze Rod, Bar, and Shapes.

2. European Committee for Electrotechnical Standardization (CENELEC) Standards

1.3 QUALITY CONTROL

A. Perform the Work included in this Section in strict accordance with Section 01400, Quality Control and Assurance.

1.4 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Certification: Furnish a certification to Caltrain verifying that all materials included in the OCS support assemblies have been designed, manufactured, inspected and tested in accordance with the Contract Documents. Additionally, submit certification to Caltrain for record purposes.

C. Test Reports: Furnish copies of reports of all factory tests required by the Contract Documents to Caltrain.

D. Manufacturer's Data: Furnish complete manufacturer's data and shop drawings to Caltrain.

E. Shop Drawings: Furnish a complete set of assembly and component drawings to Caltrain for review and approval showing dimensions, fit, weights, bill of material, catalog cuts and related product data for all OCS supporting devices proposed for use on this project.

F. Calculations: Submit, along with the Shop Drawings, a complete package of design calculations showing that the strength of hardware selection is suitable for the application, to Caltrain for review and approval.

G. Operation and maintenance data for all components addressed in this Section shall be provided in accordance with Section 34 30 93, OCS Manuals and Training.

1.5 DELIVERY, STORAGE, AND HANDLING

A. All OCS support and registration assemblies, components and materials shall be protected against damage during handling and shipping, storage and installation.

B. Store material to permit easy access for inspection and identification. Protect steel members and packaged materials from corrosion and deterioration.

C. All packaged components and/or assemblies shall have a strong waterproof tag securely fastened to the package showing the assembly or component name, number, or identification code.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials used in the components of the OCS support and registration assemblies shall be of sufficient strength and durability to withstand the applicable worst-case loads with the addition of a factor of safety of 2.5.

B. The material shall be light in weight and reliable to ensure a 40-year minimum life period.

C. The OCS support and registration assemblies shall be of a proven and tested design, which shall have successfully been used on other high-speed overhead electrified rail systems for a minimum of 5 years.

D. Furnish all labor, tools, equipment, apparatus and facilities as required to perform all fabrication and installation work as required.

E. All beam clamps, plates, anchor bolts, and other devices proposed for use in Overhead Bridge Assemblies shall be selected as appropriate for each bridge. Attachments to bridges shall only be used at structure locations specified on the Contract Documents.

2.2 METAL CHARACTERISTICS

A. Metal parts shall be manufactured in accordance with applicable DIN, EN standards or ASTM Standards.

B. For metal parts conforming to ASTM Standards, requirements shall be as follows:

1. Malleable Iron: Fittings or components made of malleable iron shall be grade 32510 or better, and shall conform to ASTM A47. All components and fittings shall be galvanized in accordance with ASTM A153.

2. Structural Steel: Material for structural steel (not including cantilever pipe) shall comply with ASTM A572 Grade 50 or ASTM A992 Grade 50. Galvanize material in accordance with ASTM A153.

3. Stainless Steel: Stainless Steel material shall conform to ASTM A484.

4. Aluminum components shall conform to ASTM B150.

5. Structural steel for overhead bridge attachments and miscellaneous devices shall conform to ASTM A572 Grade 50 or ASTM A992 Grade 50 generally conforming to the structure

receiving the attachment. Non-weathering steel applications shall be provided with a paint system, subject to Caltrain's approval.

C. Cantilever Pipe: Material for all cantilever pipe or tubes shall be aluminum in accordance with the following:

1. Standards

a. DIN EN 754 – Part 1 and 2 wrought aluminum and aluminum alloy tubes.

b. DIN EN 755 P7 - Round tubes of wrought aluminum and aluminum alloys.

c. EN 755-2 - Extruded rods/bars, tubes and profiles.

d. DIN ISO 228-1 - Pipe threads where pressure-tight joints are not made on the threads.

2. Material

a. EN AW-AlSi1MgMn according to DIN EN 755-2.

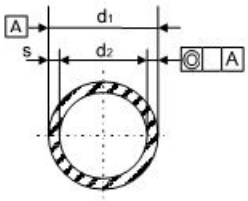
b. T6 according to DIN EN 515.

3. Tolerances

a. DIN EN 755-7, except the signed values (*).

b. Table 1: Tolerances for tubes.

Tube	**Tolerance**			**A**	**J**	**W**	**Weight**	**Application**
$d_1 \times s$	Δd mm	Δd_1 mm	Δs %	mm^2	cm^4	cm^3	$kg\ m$	
26 x 3.5	+0.30 -0.30	+0,70 -0,70	±8%	247.40	1.603	1.233	0.668	Stay, steady arm and top tube
42 x 4	+0.35 -0.35	+0.90 -0.90	±8%	477.52	8.715	4.150	1.289	Registration, top and weight guide tube
55 x 6	+0.40 -0.40	+0.60* -0.60*	±8%	923.63	28.136	10.231	2.494	Strut, top and registration tube
70 x 6	+0.40 -0.40	+0.70* -0.70*	±8%	1206.37	62.309	17.803	3.257	Strut tube
80 x 6	+0.60 -0.60	+1.40 -1.40	±8%	1394.87	96.106	24.027	3.766	Strut tube
100 x 10	+0.60 -0.60	+1.40 -1.40	±8%	2827.43	289.812	57.962	7.634	Drop tube
120 x 12	+0.90 -0.90	+1.40 -1.40	±8%	4071.50	600.954	100.159	10.993	Drop tube



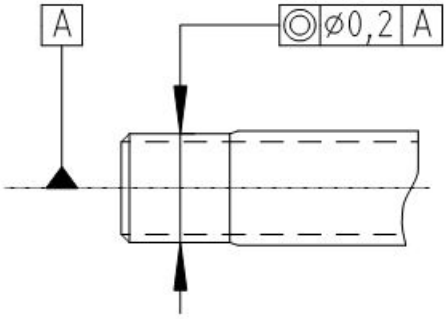
$\Delta\overline{d}$ = tolerance of deviation mean diameter

Δd_1 = tolerance of deviation diameter

Δs = non uniformity of wall thickness

Δ◎ = coaxiality based on level A

- Table 2: Coaxial tolerances for threads.



Tube $d_1 \cdot s$	Threads
26 x 3.5	G 3/4
42 x 4	G 1 1/4
55 x 6	G 1 3/4

D. All cotter pins, roll pins, spring clips, and hitch pins shall be stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Installation of OCS supporting devices shall be in accordance with Section 34 30 85, OCS Installation.

END OF SECTION

SECTION 34 30 53

GALVANIZED STEEL WIRE AND WIRE ROPE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for the supply and installation of all grades of galvanized steel wire, wire-strand terminations, wire assemblies, and wire rope for use with down guys, aerial head guys, pull-offs, backbone wire and various other usages for the Overhead Contact System (OCS) as shown on the Contract Documents and specified herein.

1.2 REFERENCED STANDARDS

A. Pertinent provisions of the following listed standards shall apply to the work of this Section, except as they may be modified herein, and are hereby made a part of this Specification to the extent required:

1. American Society for Testing and Materials (ASTM):

a. A475, Specification for Metallic-Coated Steel Wire Strand.

1.3 QUALITY ASSURANCE

A. Perform work in this Section in strict accordance with the requirements of Section 01400, Quality Control and Assurance.

1.4 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Submit manufacturer’s data sheets and related reports for each type of wire, wire rope and synthetic strand rope to be used shall contain the physical and mechanical properties of all components described in this Section. The conformance of components with the requirements of the Contract Documents shall be in the form of a manufacturer's certification. Include the following as a minimum:

1. Size
2. Type
3. Material
4. Number of and diameter of individual wires
5. Overall diameter
6. Cross-section area
7. Weight per foot
8. Rated breaking strength

9. Zinc coating weight

10. Project use and product application data

C. Provide certification that the galvanized steel wire, wire rope and synthetic strand rope have been designed, fabricated, rated and tested in compliance with the applicable provisions of the standards referenced in these Specifications.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. Manufacture zinc-coated stranded wire and tested in accordance with ASTM A475.

B. Physical properties of the zinc-coated stranded wire to conform to the description in Table 1 of ASTM A475.

C. The material used for stranded steel wire and wire components to conform to ASTM A475.

D. The weight of coating for zinc-coated steel wire not be less than that specified in Table 4, under Class C of ASTM A475.

PART 3 - EXECUTION

3.1 DELIVERY AND MARKING

A. Protect against damage during handling and shipping. Each reel shall have a strong, weatherproof tag securely fastened to it showing the physical and mechanical properties, as well as the steel type designation, ASTM designation and the name and mark of the Manufacturer, the total length and weight of the wire, wire rope or strand rope on each reel or bundle.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Galvanized steel wire, wire rope and synthetic strand rope shall be cut and installed using tools and methods specified by the Manufacturer.

B. Splicing of the galvanized steel wire, wire rope and synthetic strand rope will not be permitted under any circumstance.

C. For additional installation requirements see Section 34 30 85, OCS Installation.

END OF SECTION

SECTION 34 30 56

STAINLESS STEEL WIRE ROPE, STRAND AND ROD

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for the supply and installation of stainless steel wire rope, stainless steel wire strand and stainless steel rod for the Overhead Contact System (OCS) as shown on the Contract Drawings and as specified herein.

B. The stainless steel wire rope, strand and rod shall be suitable for the uses as shown, fully acceptable for use on a 110 mph Overhead Contact System, providing a usable and maintainable wire arrangement.

1.2 REFERENCE STANDARDS

A. The following standards shall apply and are made a part of this Specification:

1. American Society for Testing and Materials (ASTM):

a. A276, Specification for Stainless Steel Bars and Shapes.

b. A368, Specification for Stainless Steel Wire Strand.

c. A492, Specification for Stainless Steel Rope Wire.

d. A555, Specification for General Requirements for Stainless Steel Wire and Wire Rods.

e. A580, Specification for Stainless Steel Wire.

1.3 QUALITY ASSURANCE

A. Perform the work included in this Section in strict accordance with Section 01400, Quality Control and Assurance.

1.4 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Certification: Furnish certifications verifying that the stainless steel wire rope, strand and rod have been designed, manufactured, inspected and tested in accordance with the referenced standards and these Specifications.

C. Test Reports: Furnish copies of reports of all factory tests as required by these Specifications and referenced standards.

D. Manufacturer's Data: Furnish complete manufacturer's data and technical description.

E. Project Use: Furnish complete size and application data for all types of wire rope, strand and rod used for the OCS configurations, and identify for all assembly applications proposed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Ship wire rope and strand on reels suitable for the weight carried.

B. The rod shall be shipped on reels suitable for the weight carried or in straight lengths, securely bundled. Straighten rods shipped on reels prior to use.

C. Protect all material against damage during handling and shipping. On each reel or bundle, provide a strong, weatherproof tag securely fastened showing the physical and mechanical properties as well as type designation, ASTM designation and the name and mark of the manufacturer, the total length and weight of the wire rope, strand or rod on each reel or bundle.

D. Handle and store products according to manufacturer's recommendations. Leave products wrapped or otherwise protected and located under clean and dry storage conditions when necessary, until required for installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:

1. Austenitic grade stainless steel
2. High corrosion resistance
3. Compatible with component items
4. Designed to carry maximum working loads with a factor of safety of 2.5 minimum based on yield stress.

B. Stainless Steel Wire Rope:

1. Extra flexible
2. Non-rotating for use as indicated on the Contract Drawings.
3. Manufactured and tested in conformance with requirements of ASTM A368, A492, A555 and A580.

C. Stainless Steel Wire Strand:

1. Manufactured and tested in conformance with requirements of ASTM A368, A555 and A580.

D. Stainless Steel Rod:

1. Round
2. Manufactured and tested in conformance with requirements of ASTM A276.

2.2 FABRICATION

A. All material must be suitable for field adjustment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of wire rope and strand shall be in accordance with the Contract Drawings.

B. Refer to Section 34 30 85, OCS Installation.

END OF SECTION

SECTION 34 30 59

SURGE ARRESTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Description:

1. This Section specifies the manufacture, supply and installation of surge arresters for the Overhead Contact System (OCS), as shown on the Contract Drawings and specified herein.

2. Prepare detailed shop drawings for each of the required assemblies. The shop drawings for the surge arrester assemblies shall be subject to Caltrain review and approval.

1.2 QUALITY CONTROL

A. Perform the Work included in this Section in strict accordance with Section 01400, Quality Control and Assurance.

1.3 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. The following submittals shall be made prior to order and fabrication:

1. Complete manufacturer's descriptions, catalog data, and information on the surge arrester, including model number and electrical performance ratings and data.

2. Detail shop drawings of the various mounting arrangement for each location where surge arresters are installed.

3. Manufacturer's shop drawings and installation instructions on the surge arrester and all related components, including specific grounding recommendations and resistance to earth.

4. Shop drawings shall show the schematic wiring and interconnection diagrams.

5. Operation and maintenance manual, with a list of spare parts and component numbers.

PART 2 - PRODUCTS

2.1 SURGE ARRESTERS

A. Surge arresters shall be installed on the traction power substation feeder termination at the OCS side and at the catenary structure located on each side of all tunnel structures, and as shown on the Contract Drawings.

B. Surge arresters shall be of the metal oxide varistor (MOV) type, outdoor style, intermediate class, and shall be designed, constructed and tested in accordance with the general requirements of ANSI C62.11 and IEC 99-4.

C. Each surge arrester shall have the following ratings:

1. Nominal Voltage: 25 kV
2. Normal Operating Voltage: 27.5 kV
3. Maximum Normal Continuous Operating Voltage (MCOV): 31.5 kV
4. Fault Current Pressure Relief Rating no less than: 60 kA (Tested to IEEE STD C62.11)
5. Energy Distribution Capacity no less than: 9.8 kJ/kV of MCOV

D. Each surge arrester shall incorporate an individual grounding system as shown on the Contract Drawings and as detailed on the shop drawings, which must be connected to an independent ground rod or ground mat, electrically separate from the aerial ground/static wire, OCS pole ground, or any other structure grounding system.

E. Each grounding connection shall have a grounding resistance as recommended by the surge arrester manufacturer, but not greater than 5 ohms, for the type of unit supplied. Each location shall achieve the required grounding resistance recommended by the arrester manufacturer.

F. Each surge arrester's grounding arrangement shall be tested individually in accordance with the testing procedures specified in Section 34 30 49, OCS Grounding and Bonding Systems.

G. Each surge arrester shall be bonded to the grounding system by a 4/0 AWG copper wire (unless larger size wire is specified by the surge arrester manufacturer) with a minimum 2.4 kV-rated insulation.

H. Bonding cable connections between the surge arresters and the OCS, between the surge arrester and the ATF and between the surge arresters and the grounding system, shall be installed with a minimum number of bends.

I. Bonding connections between the surge arresters and the grounding systems shall be of the exothermic weld type or compression fitting UL listed for grounding applications.

J. Refer to Section 34 30 49, Grounding and Bonding Systems, for general requirements on grounding and bonding connections.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Install surge arresters at locations as specified in this specification section.

B. Install surge arresters as shown on the Contract Drawings.

END OF SECTION

SECTION 34 30 61

INSULATORS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for the supply and installation of insulators for the Overhead Contact System (OCS), as shown on the Contract Drawings and specified herein. This work shall include, but not limited to the following:

1. Cantilever Pipe Insulators
2. Messenger Wire In-Span, MPA and Termination Insulators
3. Contact Wire In-Span and Termination Insulators
4. Feeder Line-Post and Termination Insulators
5. Static Wire OCS Pole Termination at Passenger Platforms
6. Overhead Bridge Support Insulators
7. Headspan, Cross Span, Pull-Off and Aerial Head Guy Wire Insulators
8. Other Miscellaneous Insulators (as shown on Contract Drawings)

B. This Section requires that all OCS insulators conform to the features and standards stated herein and as shown on the Contract Drawings.

C. All contact wire "riding-type" insulators for use on Section Insulator assemblies are not part of this Section but are specified separately in Section 34 30 63, Section Insulators.

D. Supply and install all applicable insulators for the overhead wires and cables associated with the 2 x 25 kV AC Overhead Contact System, in accordance with the requirements specified and as shown on the Contract Drawings.

1.2 REFERENCES

A. Codes and Standards: Pertinent provisions of the following listed standards shall apply:

1. American National Standard Institute (ANSI):
   a. C2, National Electrical Safety Code.
   b. C29.1, Test Methods for Electrical Power Insulators.
2. American Society for Testing and Materials (ASTM):
   a. A153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. D149, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.

c. D229, Standard Test Method for Rigid Sheet and Plate Materials Used for Electrical Insulation.

d. D256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.

e. D570, Standard Test Method for Water Absorption of Plastics.

f. D624, Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.

g. D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.

h. D638, Standard Test Method for Tensile Properties of Plastics.

i. D695, Standard Test Method for Compression Properties of Rigid Plastics.

j. D696, Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between −30°C and 30°C with a Vitreous Silica Dilatometer.

k. D732, Standard Test Method for Shear Strength of Plastics by Punch Tool.

l. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

m. D1149, Standard Test Methods for Rubber Deterioration - Cracking in an Ozone Controlled Environment.

n. D2303, Standard Test Methods for Liquid - Contaminant, Inclined-Plane Tracking and Erosion of Insulating Materials.

o. G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

3. American National Standards Institute (ANSI):

a. C29, High-Voltage Insulators.

b. C135.20, Zinc-Coated Ferrous Insulator Clevises.

4. EN Standards:

a. 50124-1, Railway applications - Insulation coordination - Basic requirements - Clearances and creepage distances for all electrical and electronic equipment.

5. IEC Standards:

a. 61109, Insulators for overhead lines - Composite suspension and tension insulators for AC systems with a nominal voltage greater than 1000 V - Definitions, test methods and acceptance criteria.

b. 61952, Insulators for overhead lines - Composite line post insulators for AC systems with a nominal voltage greater than 1000 V.

B. Insulators may be manufactured in accordance with applicable IEC and EN standards in lieu of the ANSI/ASTM standards indicated above.

C. Factory Quality Control: Factory tests shall be made as required by these Specifications and the referenced standards. Test reports shall be submitted as detailed herein.

1.3 QUALITY CONTROL

A. The Contractor shall perform the Work included in this Section in strict accordance with Section 01400, Quality Control and Assurance.

1.4 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Submit Shop Drawings to Caltrain for review and approval prior to insulator manufacture, showing details and dimensions of the insulating and metallic parts, describing the material composing the various parts, together with technical, mechanical and electrical characteristics and performance data.

C. Prepare and submit to Caltrain an insulator device (assembly) loading data to indicate the maximum design loading condition that each type of insulator can safely withstand.

D. Submit as per test plan to Caltrain for approval, details of the factory tests proposed for each insulator and the procedures and forms to be used during the factory tests and inspection.

E. Certification:

1. Provide certificates of compliance to Caltrain for the following:

    a. Steel analysis

    b. Hot dip galvanizing

    c. Adhesive materials

    d. Insulator materials

    e. In-service performance record of proposed insulators

    f. Certified Quality Control Procedures used in the manufacturing process

2. Submit data to Caltrain for approval prior to insulator installation:

    a. A complete set of assembly, component, and detail drawings showing dimensions, weights and the form, fit and function of all items.

    b. Storage, handling and installation instructions.

    c. Details of any specifications for materials included in the insulator assembly which are not covered in the Contract Documents.

F. Inform Caltrain at least two (2) weeks in advance of the date on which insulators will be ready for inspection and tests.

G. Submit one sample to Caltrain of each type of insulator to be used on the project.

H. The insulators shall be maintenance free. If the manufacturer/suppler recommends specific maintenance procedures and service data, they shall be submitted to Caltrain prior to the manufacture and supply of all insulators.

1.5 DELIVERY, STORAGE AND HANDLING

A. Ensure that all materials furnished are suitably packaged and protected against damage during delivery and transportation.

B. Store all products in accordance with the manufacturer's instructions, to ensure that all material is protected from damage and exposure.

C. Handle the insulators in accordance with the manufacturer's instructions, so as to ensure that the products are not damaged or misused prior to or during installation.

D. Repair or replacement any damaged insulators in accordance with the manufacturer's instructions.

1.6 WARRANTY

A. The insulators shall have a minimum in-service life expectancy of 40 years under normal high speed rail operating conditions.

B. The insulators shall be unconditionally guaranteed in writing by the manufacturer and/or supplier to be free from operational and manufacturing defects for a period of not less than 5 years.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. The insulators covered by this Specification are for use in the following applications, and are to be non-ceramic:

1. OCS Insulators

a. Cantilever Pipe Insulators - for the configuration and insulation of the OCS assembly pipe/tube frames, mounted to the poles. These shall be manufactured from glass fiber reinforced resin with suitable weathersheds.

b. Messenger Wire In-Span and Termination Insulators - For the vertical and horizontal support, cut-in (tension) and termination (strain) of the main messenger wire which supports the OCS hangers and contact wire. These shall be manufactured from glass fiber reinforced resin with suitable weathersheds.

c. Contact Wire In-Span and Termination Insulators - For the horizontal cut-in (tension) and termination (strain) of the grooved contact wire for the Overhead Contact System. These shall be manufactured from glass fiber reinforced resin with suitable weathersheds.

d. Contact Wire Non-Riding Insulators - For the horizontal insulation of the grooved contact wire as a cut-in (tension) member used on short span overlaps where uplift may cause the pantograph to hit a normal weathershed insulator. These shall be manufactured from glass fiber reinforced resin without weathersheds.

e. Feeder Termination and Line-Post Insulators - For the 25 kV AC system feeder wires supported on the OCS structures. These shall be manufactured from glass fiber reinforced resin with suitable weathersheds.

f. Headspan, Cross Span, Pull-Offs and Aerial Head Guy Termination Insulators - For the horizontal insulation of the headspan, cross span, pull-off wire and aerial head guy termination wires. These shall be manufactured from glass fiber reinforced with suitable weathersheds.

2.2 NON-CERAMIC INSULATOR MATERIALS

A. The non-ceramic insulators shall be of varying types, dependent upon usage. Non-ceramic insulators with cast composite bodies may incorporate performance-proven metal threaded inserts. Other non-ceramic insulators will be a unit consisting of a non-metallic rod, weathersheds as required, and end fittings. The rod shall be made of glass fiber or reinforced polymer (silicon, rubber, teflon, or cycloalipathic resin), with its fibers running longitudinally through the rod length. The rod may be attached to the end fittings or hardware by a compression sleeve, wedge or adhesive. If adhesive is used, the adhesive shall encapsulate the rod in the end-fitting cavity and shall form a compressive wedge upon loading. Weathersheds shall, for the expected life of the insulators, protect the rod from the elements and insure the necessary leakage distance.

B. The non-ceramic insulators shall be constructed so as to be a lightweight, compact unit with high-impact strength. Weathersheds shall be "self-cleaning" and weather resistant to reduce the possibility of ice-bridging between sheds. They shall be of a material that is vandal resistant insofar as being shatter- proof, thereby reducing vandalism damage.

C. The insulator's metal parts shall be made of malleable iron, ductile iron, or forged steel and be galvanized in accordance with ASTM A153 or applicable European Standard. Metal parts shall be galvanized prior to assembly to the fiberglass rod or composite material insulator body.

D. All insulator types used shall be capable of withstanding service in an environment which includes exposure to ultraviolet radiation, moisture, surface discharges, ozone, temperature extremes, diesel engine exhaust fumes, and a diversity of contaminants such as industrial pollutants.

E. The insulators shall be designed to be capable of maintaining the integrity of the weathershed material at all component interfaces. The interface between fiberglass rod and weathershed, or composite material body and weathershed shall, for the life of the insulator, remain void-free and dry. Color shall be manufacturer’s standard.

F. The resin-bonded glass fiber rods shall be sound and free from any defects or blemishes which may affect the life and performance of the insulator. It shall be of uniform quality throughout its length.

G. All non-ceramic material shall have a smooth, void-free finish. All adhesive coatings shall be sealed to the fittings to protect them against the ingress of moisture.

H. The design shall be such that stress due to temperature variation, and mechanical extension/contraction in any part of the insulator under load and normal handling, shall not lead to deterioration. The materials used shall not cause degradation by chemical interactions.

I. The end fittings attached to the fiberglass rod type insulator shall ensure exact alignment with the rod and correct assembly in respect to each other to avoid torsional stress when the insulator is installed.

J. The insulators shall be so designed that no sparking or arcing shall occur on or across the surface of the insulator when energized at the maximum design voltage under clean and dry conditions.

K. The insulators shall be designed to suit the various catenaries and assembly arrangements, as shown.

L. The Contractor may submit non-ceramic insulators of alternative designs to Caltrain for approval. The alternative design shall meet or exceed all electrical, mechanical, dimensional, environmental, and other technical characteristics as specified herein, and all types shown have a proven OCS in-service history of not less than 5 years.

2.3 SPECIFIC REQUIREMENTS

A. All insulators shall include the fittings and connections for attachment to the pipe, pole or steelwork, as shown.

B. The insulator shall be suitable for both horizontal and vertical mounting and installation, unless otherwise specified.

C. The skirt or weathershed of all insulators shall be of sufficient diameter to meet the electrical requirements.

D. The insulators shall be formed to fit the specified conductors as shown on the Contract Drawings.

2.4 TECHNICAL CHARACTERISTICS AND DIMENSIONS

A. Technical characteristics of the insulators shall be as shown and indicated herein.

B. Insulator Characteristics:

1.	Nominal Voltage:	25 kV AC
2.	Insulation class:	46 kV
3.	Basic Insulation Level:	250 kV AC, RMS
4.	Creepage Distance:	45” (min)
5.	Dry Flashover:	160 kV
6.	Wet Flashover:	125 kV

2.5 MARKING

A. Each insulator shall bear the manufacturer's name or trademark and year of manufacture, clearly and permanently imprinted or attached without leaving any irregularity that would affect the electrical and mechanical performance of the insulator.

2.6 PRODUCTION TESTS AND FABRICATION

A. The following tests shall be performed in accordance with ANSI C29.1 and Test Plan:

1. Visual and Dimension Test:

a. The entire surface shall be smooth and free from defects.

b. If adhesives are used, the insulator shall be inspected to see that the filet of adhesive provides a complete seal between the coating and end fitting.

c. The insulator shall be inspected to verify that both end fittings are in line after being assembled on the rod.

d. The insulator shall be in accordance with shop drawings for which Caltrain has issued an approval, and these specifications.

2. Routine Flashover: A sampling of not less than 5 percent of each type of insulators shall be subjected to a flashover test in accordance with ANSI C29.1. For this test, an electrode shall be placed at each side of, and adjacent to, the non-ceramic barrier. Should any test specimen fail, all insulators in the production batch of that specimen are subject to rejection. Alternatively, each insulator in the batch may be tested. Any insulators that puncture will be cause to have the insulator design rejected.

3. Proof Test: Ten insulators of each insulator type shall be subject to a mechanical strength proof test. The insulators shall be tested at room temperature for ten seconds to 120 percent of the designed tensile, compressive or bending load. Failure shall constitute rejection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The insulators shall be installed in accordance with the Contract Drawings and as specified in Section 34 30 85, OCS Installation.

B. All factory tests shall be completed and test reports subsequently submitted to Caltrain for review and approval with a record copy sent to Caltrain prior to shipment of any insulators to the jobsite.

END OF SECTION

SECTION 34 30 63

SECTION INSULATORS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for the supply, installation, and testing of section insulators for the Overhead Contact System (OCS), as shown on the Contract Drawings and specified herein. Provide service-proven units.

1. Section insulators are units in the OCS which achieve electrical isolation while allowing physical clearance for the smooth passage of a pantograph.

2. Bridging type section insulators used for sectionalizing purposes, as shown, shall permit continuous current collection.

3. Non-Bridging type section insulators used for sectionalizing purposes (typically at Yards and Shops) and at Phase Break locations shall insure the electrical isolation of adjacent sections of OCS during all phases of pantograph passage.

1.2 REFERENCE STANDARDS

A. Pertinent Provisions of the latest revision of applicable NEMA, IEEE and ANSI Standards shall apply to the work of this Section, except as they may be modified herein, are hereby made a part of this Specification to the extent required.

B. Section insulators may conform to applicable European EN and IEC Standards in lieu of NEMA, IEEE, and ANSI Standards.

1.3 QUALITY ASSURANCE

A. Perform the Work included in this Section in strict accordance with the requirements of Section 01400, Quality Control and Assurance.

1.4 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Submit the following information for approval, prior to fabrication:

1. Insulators:

a. Electrical:

i. Creepage length (inches)

ii. Insulation level (impulse withstand test voltage, kV)

iii. AC test voltage (kV)

b. Mechanical:

i. Attachment centers and overall length (inches)

ii. Shed diameters (inches)

iii. Core diameters (inches)

iv. Tensile test withstand breaking load (pounds)

v. Recommended maximum working tensile load (pounds)

vi. Material

2. Manufacturer's design safety factors.

3. Shop drawings of hardware and components.

4. Listing and description of components and hardware.

5. Shop drawings and installation instructions required for field forming and setting of contact wire into mating items, including gliders.

6. For assemblies, list values of BIL, ultimate tensile strengths, ultimate torsional strength, weights (including weight of components), maximum speed rating, and electrical characteristics.

C. Submit O&M Manuals covering complete instructions for the section insulator installation, operation, maintenance and testing. Provide a complete replacement parts lists. Provide all manuals in accordance with Contract Documents.

D. Submit reports for the following factory tests:

1. Field tests

E. Submit manufacturer full information, with supporting documentation, on the in-service performance history of the proposed section insulators.

1.5 DELIVERY, STORAGE AND HANDLING

A. Ensure that all section insulator materials are suitably protected against damage during transport, handling and storage.

B. Store all products in accordance with the manufacturer's instructions, to ensure that all material is protected from damage and exposure.

C. Handle and otherwise use the section insulators in accordance with the manufacturer's instructions, so as to ensure that the products are not damaged or misused prior to or during installation.

D. Replace or repair damaged section insulators. All required repairs and replacements shall be accomplished in accordance with the manufacturer's instructions.

PART 2 - PRODUCTS

2.1 PRODUCT CRITERIA

A. Provide section insulators suitable for use in all styles and configurations of the Overhead Contact System. Section insulator shall remain stable (dynamically and structurally) under sustained crosswinds of up to 55 mph and withstand maximum crosswinds of 110 mph without failure or permanent deformation.

B. Position section insulators, in general, adjacent to an OCS support point. Insulators are to be compatible with in-span installation requirements, providing the span lengths are suitable and messenger heights are sufficient to allow for the extra sag or used with an along track aerial head guy support cable. Provide arrangements of OCS showing the section insulator locations for approval.

C. Provide section insulators capable of continuous operation at the nominal OCS voltage of 25 kV AC under all operational weather conditions specified for the project area.

D. Assembly and component parts shall ensure ease of adjustment, maintenance, replacement, assembly, and disassembly with a minimum of specialized tools.

E. Provide a riding overlap of the conductive runners on bridging type assemblies to ensure continuous current collection.

F. Provide messenger insulation of non-ceramic material in accordance with Contract Documents.

G. Provide contact wire insulator of glass fiber reinforced synthetic resin or polymer. Provide insulator with 46 kV class insulation and with a BIL of 250 kV.

H. Provide stabilizing hangers (with suitable means of field adjustment) from the messenger to restrict the rotational movement of the section insulator and to ensure correct alignment of the runners with respect to the pantograph.

I. The interface and connection of the contact wire insulator to the runners shall permit a smooth riding path without pantograph carbon damage and dynamic collector bounce. The mass of the connection and the skids shall be as small as possible. Provide skids with field adjustment to achieve alignment with the pantograph and the contact wire.

J. Space the runners on the section insulator such that both sides are always in contact with the working portion of the pantograph.

K. Insulators and their end fittings shall be suitable for the maximum working tensions of the conductors as shown. A factor of safety of 2.5 minimum, is required for all components of the section insulator.

L. Provide lightweight components, particularly those associated with the contact wire.

M. Provide insulators capable of operating with multiple pantograph passes at speeds from zero (0) to a maximum of 55 miles per hour through a #20 crossing, without sustaining damage or causing OCS operational problems.

2.2 MANUFACTURE

A. Supply section insulator complete in all respects suitable for installation.

B. Hot-dip galvanized all steel and malleable or ductile cast iron fittings in accordance with ASTM Specification A-l53 or A-386. Accomplished prior to assembly of the section insulator.

C. Testing:

1. All tests shall be conducted by the manufacturer. Caltrain reserves the right to attend the tests. The Contractor shall inform Caltrain not less than 10 days in advance of testing operations. A certified test report shall be supplied whether or not Caltrain attends the tests.

2. Provide test data or reference applicable field operational experience for the same product in a similar application. This performance history shall demonstrate that for a 5 year in-service period, all weathershed material experiences no failure or detrimental effects from ultra-violet radiation and electrical tracking.

3. The related messenger insulators (for section insulators not supported from an aerial head guy) shall be tension-proof tested in accordance with the applicable section of the Specifications, and all of the contact wire section insulator units shall be tension-proof tested to withstand 2.5 times the worst-case contact wire tension.

4. Submit all test reports prior to shipment of any components.

5. Test each type of section insulators for dry flashover, wet flashover, low frequency, dry and wet withstand and impulse withstand tests. Perform tests in accordance with applicable ANSI/IEEE.

6. Electrical criteria shall be the same as for other insulators on the project, in accordance with the Contract Documents.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Refer to Section 34 30 85, OCS Installation.

END OF SECTION

SECTION 34 30 69

BALANCE WEIGHT ANCHOR ASSEMBLY

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for the supply, installation and testing of balance weight anchor, and mid-point anchor assemblies for the Overhead Contact System (OCS), as shown on the Contract Drawings and specified herein.

B. The Balance Weight Anchor (BWA) assemblies automatically regulate the tension of the Simple Catenary Auto Tensioned (SCAT) style by compensating for variations in conductor lengths resulting from changes in temperature due to ambient, solar and electrical heating variations.

C. For a full wire run tension length, a Mid-Point Anchor (MPA) assembly is typically located approximately one-half of the distance between the termination ends (where the BWA are located) and serves to secure the messenger wire and contact wire from along-track movement at this central point. This effectively divides the full wire run length into two (2) "half-tension" lengths between the MPA and the BWA at each end. In addition, half-tension length wire runs are utilized where BWA are located at one termination end and Fixed Termination Anchors (FTA's) are positioned at the other wire run termination. Half tension runs of this configuration do not use a MPA assembly.

1.2 REFERENCE STANDARDS

A. American Society for Testing Materials (ASTM)

1. A27, Specification for Steel Castings, Carbon, for General Application.

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

3. A47, Specification for Ferritic Malleable Iron Castings.

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

5. A153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

6. A240, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

7. A307, Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.

8. A518, Specification for Corrosion-Resistant High-Silicon Iron Castings.

9. A536, Specification for Ductile Iron Castings.

10. A668, Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.

11. A711, Specification for Steel Forging Stock.

B. The BWA may be manufactured in accordance with applicable IEC and EN standards in lieu of the ASTM standards indicated above.

1.3 QUALITY ASSURANCE

A. Perform the Work included in this Section in strict accordance with Section 01400, Quality Control and Assurance.

1.4 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Submit the following Shop Drawings and list of special tools as follows:

1. A complete set of Shop Drawings showing the BWA unit assemblies, all components, and a Bill of Material giving dimensions, weights, and related design and product data. Appropriate shop drawing and site-specific installation charts shall be provided for each BWA units supplied.

2. List of special tools, required for the BWA assemblies and installation.

C. Provide supplier's certificate of compliance accompany each shipment of a BWA assembly. As a minimum, it shall contain the following:

1. Product Name

2. Drawing Number and revision or date

3. Quantity

4. Purchase Order Number

5. List of specifications to which the product was produced

6. Supplier's name and address

7. Signature and title of recognized quality authority

D. All factory and other test reports as indicated shall be submitted.

E. Operation and maintenance data for BWA shall be provided, in accordance with Section 34 30 93, OCS Manuals and Training.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Package OCS BWA assemblies in a manner to allow stacking and outdoor storage until installation with no harmful effects.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. The BWA assembly shall maintain essentially constant tension in the conductors to compensate for changes in ambient, solar or current heating temperatures. Changes in the lengths of conductors shall be compensated for by an equivalent change in the position of the balance weight stack. The BWA assembly shall accommodate vertical movement of the weights due to OCS behavior at conditions from 20^{o} F (no ice) and 145^{o} F.

B. The BWA wheel assembly shall have an effective 1:3 ratio suitable for the wire rope types used to achieve operation over the required temperature range.

C. The BWA assembly shall be suitable for the wire rope types used and shall be equipped with weatherproof bearings rated for outdoor (exposed) use in San Francisco to San Jose, California environment described in the Contract Documents.

D. The BWA assembly shall operate freely under all climatic conditions within the limits specified.

E. Balance weights shall typically be fabricated of cast iron or malleable iron casting, with a vandal-proof assembly.

F. Weight sets are to be individual castings. Individual castings shall be of an interlocking design to prevent slippage. The assembled stack of weights shall be cylindrical in shape. An acceptable alternative is to cast the weight as a single cylindrical member.

G. Tolerance on the complete balance weight stack shall be -0 lbs to +50 lbs.

H. Weights shall be compact, allowing for the required vertical movements provided by the available length of the support pole.

I. The BWA assembly shall have a minimum design life of 40 years and shall not normally require preventative maintenance or inspection at intervals of less than 12 months. The BWA design shall permit access to the weight stack during installation and subsequent maintenance. The BWA assembly shall be suitable to maintain a constant tension of 12 kN (2,700 lbf) in the messenger wire and 14 kN (3,150 lbf) in the contact wire at temperature conditions indicated in Paragraph 2.1.A above.

J. Assemblies and component parts shall be designed for ease of maintenance, replacement, assembly, and disassembly, which shall be accomplished with a minimum of special tools. Component parts shall be properly identified for this purpose. All special tools required to service and maintain the BWA assembly shall be provided.

K. Incorporate provisions for adjustment due to wire elongation (stretch).

L. All materials and the unit design shall have been proven by the manufacturer's experience to be suitable for the purpose for which they are intended. They shall be suitable for the loads and climatic conditions existing in the project as noted in the Contract Documents.

M. All external ferrous parts shall be stainless steel or hot-dip galvanized in accordance with the appropriate ASTM specification. Any ferrous parts which are not stainless steel shall be hot-dipped galvanized.

2.2 TESTING

A. Inspect and factory test the BWA assemblies to ensure that they satisfy the requirements noted in the Contract Documents and shop drawings. Submit a test report certifying these requirements.

B. Submit copy of Type Tests including Fatigue Tests, and Release Tests.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Refer to Section 34 30 85, OCS Installation.

END OF SECTION

SECTION 34 30 73

OCS FITTINGS AND HARDWARE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for the supply and installation of ferrous and non-ferrous metallic components, line material, hardware and fittings for the Overhead Contact System (OCS), as shown on the Contract Drawings and specified herein. The Work includes but is not limited to the following:

1. Hanger Assemblies
2. Wire Cross Assemblies
3. Wire Splices
4. Clevis-Clevis Fittings
5. Wire Terminations
6. Parallel Wire Clamps
7. Nuts, Bolts, Washers and Cotter Pins
8. Messenger Wire Dead Ends
9. Links, Straps and Eyebolts
10. Messenger and Contact Wire Terminations
11. Double Clevis End Fittings
12. Thimbles and Turnbuckles
13. Wire Sleeves
14. Messenger Suspension Clamps and Span Wire Supports
15. Wire Clamps
16. Wire Connectors and Saddles
17. Wire Adjustable Straps
18. Strain Clamps
19. Knuckle Assemblies and Wire Spacers
20. Trunnion Clamps
21. Pole Bands and Connectors

22. Other specialized fittings and hardware necessary to erect the complete OCS system.

1.2 REFERENCE STANDARDS

A. Codes and Standards: Pertinent provisions of the following listed standards shall apply to the work of this Section, except as they may be modified herein and are hereby made a part of this Specification to the extent required.

1. Ferrous Metals:

a. American Society for Testing and Materials (ASTM):

i. A27, Specification for Steel Castings, Carbon, for General Application.

ii. A47, Specification for Ferritic Malleable Iron Castings.

iii. A153, Specification for Zinc coating (Hot-Dip) on Iron and Steel Hardware.

iv. A193 Grade B7, Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.

v. A518, Specification for Corrosion-Resistant High Silicon Cast Iron.

vi. A536, Specification for Ductile Iron Castings.

vii. A668, Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.

viii. A711, Specification for Steel Forging Stock.

ix. A747, Specification for Steel Castings, Stainless, Precipitation Hardening.

2. Non-Ferrous Metals:

a. American Society for Testing and Materials (ASTM):

i. B26, Specification for Aluminum-Alloy Sand Castings.

ii. B148, Specification for Aluminum-Bronze Sand Castings.

iii. B179, Specification for Aluminum Alloys in Ingot and Molten Forms for Castings from All Casting Processes.

iv. B248, Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strips and Rolled Bar.

v. B249, Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar and Shapes.

vi. B557, Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products.

vii. B584, Specification for Copper Alloy Sand Castings for General Applications.

viii. B686, Specification for Aluminum Alloy Castings, High-Strength.

B. OCS fittings and hardware may be manufactured in accordance with applicable DIN and EN standards in lieu of the ASTM standards indicated above. Wherever possible use fittings and hardware of Imperial System (English units).

1.3 QUALITY ASSURANCE

A. Perform the Work included in this Section in strict accordance with the requirements of Section 01400, Quality Control and Assurance.

1.4 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Submit Shop Drawings for all OCS hardware assemblies and components, prior to manufacture, showing details and dimensions, and giving designations of the materials comprising the various components together with technical, mechanical and electrical data as appropriate.

C. Submit to Caltrain or make available at warehouse one sample for each of the major assemblies and components listed below.

1. Messenger wire saddles
2. Contact wire clamps
3. Hanger assemblies
4. Wire splices
5. Messenger suspension clamps
6. Messenger span wire supports
7. Messenger and contact wire terminations
8. Parallel wire clamps

D. Provide operational (installation) and maintenance data, including specified fastener torque requirements, all components addressed in this Section and/or utilized in the work.

1.5 DELIVERY, STORAGE AND HANDLING

A. Cast the identification mark of the manufacturer or foundry and the pattern numbers assigned by the supplier into all castings. Marks and numbers shall be readable size, and in such a position that they will not affect their electrical or mechanical performance.

B. Pack fittings and hardware in accordance with the best commercial practice, adequate to ensure acceptance and safe delivery.

C. Mark all shipping boxes, bags, or crates showing the contents of each. If different materials are packaged in a box, bag or crate all items of a kind should be boxed, bagged or crated and properly marked or tagged prior to placement in the shipping vessel.

D. Pack OCS fittings and hardware in a manner to allow stacking and outdoor storage until final installation with no harmful effects.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Material for hardware and fittings shall comply with the applicable standards. Substitutions will be considered if the requirements of the Contract Documents are satisfied, subject to Caltrain's review and approval. Hardware and fittings shall satisfy the complete form, fit and function of all OCS components and hardware which make up the OCS assemblies and equipment, as shown on the Contract Drawings.

B. All materials and components used in the OCS assemblies shall be of sufficient strength and durability to withstand the calculated loads with addition of a minimum factor of safety of 2.5. Messenger and contact wire fasteners and terminations shall meet a factor of safety of 2.0. The factor of safety shall be greater than 2.5 when indicated in the Contract Documents and where recommended by the manufacturer.

C. Optional hardware may be installed such as turnbuckles and guy grips, may not be indicated on the Contract Documents or assembly shop drawings, to facilitate installation. The strength and quality of this optional hardware shall meet or exceed the strength and quality of the other hardware in the assembly. Introduction of this optional hardware shall not alter the function of the completed assembly. All optional hardware shall be submitted for Caltrain's review through the shop drawing process prior to their supply and installation with a record copy sent to Caltrain.

2.2 METAL CHARACTERISTICS

A. Metal fittings and hardware shall be manufactured in accordance with applicable DIN, EN standards or ASTM Standards.

B. For metal fittings and hardware conforming to ASTM Standards, requirements shall be as follows:

1. Provide malleable iron fittings or components conforming to grade 32510, or better, and to ASTM A47. Galvanize all components and fittings in accordance with ASTM A153.

2. Material for forged steel shall comply with ASTM A711 or A668. Galvanize all components and fittings in accordance with ASTM A153.

3. Provide fittings or components requiring high yield strength having a ductile iron, grade 60.40.18 or fittings and components conforming to ASTM A536. Galvanize all fittings and components in accordance with ASTM A153.

4. Stainless Steel hardware shall conform to ASTM A747.

5. Copper alloys for fittings and components shall conform to ASTM B584 and B148.

6. All copper components shall conform to ASTM B248 or B249.Aluminum components shall conform to ASTM B26, B557 and B686.

C. All cotter pins, roll pins, spring clips and hitch pins, shall be made out of stainless steel.

2.3 FABRICATION

A. The designated metals shall be produced by a method that will meet the requirements of this Section.

B. Castings shall be of uniform quality and shall be made in such a manner that the material of the casting conforms to the chemical and mechanical properties prescribed in the referenced ASTM standards.

2.4 WORKMANSHIP, FINISH, AND APPEARANCE

A. The castings shall be free of adhering sand, voids, cracks, surface porosity and non-uniform dimensions.

B. The form, function and fit, including the dimensional accuracy of all OCS assembly, equipment fittings and hardware shall be complied with the Contract Documents.

C. Repairs to fittings and hardware shall be permitted only to the extent allowed by the applicable ASTM, IEC, or EN standards. Obtain approval from Caltrain prior to accomplishing any repair.

D. Malleable iron, ductile iron, forged steel and mild steel components in contact with the pole surface (if other than galvanized) shall be painted to match the finish of the pole. Should galvanized components be furnished, the paint system used shall be compatible with the galvanizing.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Installation requirements for OCS fittings and hardware shall be in accordance with the manufacturer's recommendations and the Contract Documents.

3.2 COMPONENT PERFORMANCE AND USABILITY

A. All fittings and hardware used for the OCS assemblies shall be selected and made such that they can be reused after removal (except for pole banding, wire splices and compression sleeves and caps).

B. All fittings and hardware shall be designed for easy interface with the other components of the electrification system.

C. All fittings and hardware shall be designed to provide a fully functional, homogenous OCS hardware and assembly arrangement.

D. Components and assemblies shall be designed such that all fastenings and adjustments are accomplished with the same dimensional standards or tools.

END OF SECTION

SECTION 34 30 76

DISCONNECT SWITCHES FOR OCS SECTIONALIZATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for the supply, testing and installation of overhead line disconnect switches and associated equipment for sectionalization of the 2 x 25 kV AC Overhead Contact System (OCS), as shown on the Contract Drawings and specified herein.

1. Prepare detailed shop drawings for each of the required disconnect switch assemblies, based on the general concepts specified on the Contract Drawings and the information stated in this Section.

2. This Section covers motorized and manually operated switches.

B. This Section does not cover 25 kV disconnect switches at Traction Power Facilities. See Specification Section 34 31 66 (under future development) for disconnect switches at Traction Power Facilities.

1.2 REFERENCE STANDARDS

A. Pertinent provisions of the following listed standards shall apply to the work of this Section, except as they may be modified herein, and are hereby made a part of this Specification to the extent required:

1. Institute of Electrical and Electronics Engineers (IEEE):

a. C37.30.1, Standard Requirements for High-Voltage Switches.

b. C37.32, Schedule of Preferred Ratings, Manufacturing Specifications, and Application Guide for High-Voltage Air Switches, Bus Supports, and Switch Accessories.

c. C37.34, Test Code for High-Voltage Air Switches.

d. C37.35, Guide for Application, Installation, Operation and Maintenance of High-Voltage Air Disconnecting and Interrupter Switches.

e. C37.37, Loading Guide for AC High-Voltage Air Switches.

2. American Society for Testing and Materials (ASTM):

a. B187, Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes.

3. National Electrical Manufacturers Association (NEMA):

a. ICS 1, General Standards for Industrial Control and Systems.

b. ICS 2, Industrial Control Devices, Controllers and Assemblies.

4. National Fire Protection Association (NFPA):

a. National Electrical Code (NEC), latest Edition

1.3 QUALITY ASSURANCE

A. Perform the work included in this Section in strict accordance with the requirements of Section 01400, Quality Control and Assurance.

1.4 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Submit the following information prior to fabrication:

1. Disconnect Switches:

   a. Fully detailed technical specifications of disconnect switch, with dimensioned outline drawings which fully exhibit the principal features of the switch equipment. These drawings shall clearly indicate what provision will be made for fixing the isolator base to the supporting steel work.

   b. Details of the electrical ratings of the disconnect switch.

   c. Dimensioned outline drawings which fully exhibit the principal physical features of the switch equipment.

2. Operating Mechanisms:

   a. Detailed drawings of each type of operating mechanism for motor and manual operated switches showing the overall dimensions, and the means of securing to the supporting structure.

   b. For each type of motorized operating mechanism, provide the specifications for:

      i. Rated supply voltage.

      ii. Current required at rated supply voltage to operate the isolator.

      iii. Operating time.

      iv. Insulation rating.

      v. Full load power rating of motor at rated voltage.

      vi. Power rating of anti-condensation heater.

      vii. Current interrupting capability.

3. Insulators:

   a. A general Specification of each different type of insulator, including:

      i. Electrical and mechanical ratings.

      ii. Dimensioned outline drawings which fully illustrate the principal physical features of the insulators.

4. Guides:

    a. A drawing of the drive pipe guide, indicating what provision will be made for fixing the guide to the supporting structure.

    b. Number and spacing of guides required for each drive pipe.

5. Operation & Maintenance Manual:

    a. Five (5) copies of the installation, operation and maintenance manual shall be provided for the proposed disconnect switches, in accordance with Section 34 30 93, OCS Manuals and Training.

    b. Additionally, one (1) complete set of as-built drawings and the installation, operation and maintenance manuals shall be shipped with each disconnect switch unit.

C. Submit requirements and production/factory tests reports within 1 week after completion of each component testing procedure.

1.5 FACTORY TESTS

A. General: Disconnect switches shall be tested at the factory prior to shipment, as specified herein.

B. Type Tests:

1. Disconnect Switches:

    a. Tests to verify the insulation level

    b. Tests to prove that the temperature rise of any part does not exceed the values specified

    c. Tests to prove the capability of the switch to carry the rated short time current

    d. Tests to prove satisfactory operation and mechanical endurance (1,000 operations minimum per IEEE C37.30.1)

2. Electric Motors:

    a. Provide tests in accordance with the requirements of the relevant references.

    b. Fully detailed type testing reports must be provided.

3. Where these tests have previously been undertaken on equipment similar in all respects likely to affect its performance during a particular test or series of tests, Type Test Certificates may be submitted for acceptance.

4. Perform tests in accordance with IEEE testing standards, and the manufacturer shall clearly list its testing procedures and references of standards.

C. Sample Tests:

1. Sample tests to be carried out at the manufacturer's factory in accordance with the routine tests noted below. The responsibility for inspection of all components in accordance with

the appropriate specifications is delegated to the manufacturer, but the Contractor and Caltrain reserve the right to witness the inspection and testing.

2. The following routine tests shall be carried out in accordance with:

   a. Power-frequency voltage dry tests of the main circuit.

   b. Measurement of the resistances of the main circuit.

3. Perform tests in accordance with IEEE testing standards, and the manufacturer shall clearly list his testing procedures and references of standards.

PART 2 - PRODUCTS

2.1 GENERAL

A. The Overhead Contact System is a 2 x 25 kV AC system. The OCS conductors will be energized at a nominal single phase voltage of +25 kV to rail. Maximum Line-to-Line Voltage is 55 kV. Maximum Line-to-Ground Voltage is 27.5 kV. The 25 kV disconnects shall be single pole and double pole type as indicated in the Contract Documents.

B. Locate disconnect switches on designated catenary poles along the mainline electrified railroad. Switches shall be designed to withstand the conditions specified in Section 34 30 03, OCS General Requirements.

C. Owing to the exposed nature of the system, frequent short circuits of varying severity are likely to occur. The switch equipment supplied shall withstand the effects of any short circuits up to the maximum value 38 kA for 3 seconds for a 1200A switch, unless otherwise noted.

D. It is expected that the switch equipment will be subjected to some ground vibration during the passage of trains. All switch equipment shall be designed to withstand such vibration. Experience with similar switch equipment on railway installations is required.

E. Replaceable parts shall be interchangeable.

F. Adequately ground all switch equipment to ensure the protection of the equipment and the safety of those concerned in its operation and maintenance.

2.2 SWITCH TYPES AND RATINGS

A. Switch Type Reference:

   1. Type A1 – Double Pole, 55 kV Line to Line, 27.5 kV Line to Ground, Open/Close

   2. Type B1 or B2 – Single Pole, 27.5 kV Line to Ground, Open/Close

B. Provide disconnect switches, manually or remote motor operated, depending on the application.

C. Details of the operating mechanisms are given below in paragraphs 2.3 E, F and G. Switches will remain in the same operating position (open or close) for long periods of time without being operated.

D. Ratings: Disconnect switches shall comply with the following:

   1. Rated Normal Current Type A1 1200A

		Type B1 1200A
		Type B2 600A
2.	Rated 3 sec. Short Time Current:	38 kA for 1200A Switch
		25 kA for 600A Switch
3.	Momentary asymmetrical	61 kA for 1200A Switch
	current rating	40 kA for 600A Switch
4.	Pole spacing	52 inches
5.	Frequency	60 Hz.
6.	Voltage Class	46 kV

E. Switches shall be have limited current interrupting capability as follows:

1.	Current interrupting capability	600A
2.	Emergency interrupting capability	900A

2.3 CONSTRUCTION

A. Insulation:

1. Provide cylindrical post insulators in accordance with ANSI standards and shall be capable of withstanding all mechanical loads imposed during switch operation. Insulators shall comply with the following electrical requirements:

   a. Basic Lightning Impulse:

i.	BIL:	250 kV
ii.	Leakage Distance:	43 in.

   b. The insulation level of the disconnect switch (48.3 kV rms maximum voltage) shall comply with the following requirements:

i.	Dry impulse withstand voltage	250 kV minimum
ii.	Wet withstand voltage, 10 sec	100 kV minimum
iii.	Dry withstand voltage, 1min.	120 kV minimum

B. Contacts:

1. The moving blade shall be of copper or aluminum with tinned contact surfaces.

2. Disconnect switches shall have fixed jaws with replaceable tinned copper contacts.

3. Provisions shall be made for coarse and fine adjustments of the contacts within the housing.

4. A mechanical stop shall be incorporated within the assembly to prevent over-travel of the isolator blade tip.

C. Couplings:

1. Disconnect switches shall incorporate all components necessary for connecting to the drive pipe (operating rod).

D. Special Requirements:

1. Any bearing assemblies shall, when necessary, be packed with grease and adequately sealed against the ingress of moisture and other contaminants.

2. The base of any moving insulator shall be electrically bonded to the main base of the switch in order to ensure a low resistance path for fault current. The connection should be made with a flexible conductor of sufficient size to withstand the rated short time current.

3. Disconnect switches shall be designed so that the drive pipe acts on the moving part through an insulator. The drive pipe shall be bonded.

E. Drive Pipes:

1. Drive pipes shall be of galvanized heavy steel pipe for use with pole-mounted switch.

2. The drive pipes shall be supplied complete with all necessary guides.

F. Manual Operator (Open/Close):

1. Operation shall be by means of a handle (lever) moving in a horizontal plane. When not operating, handle shall be folded in a vertical plane.

2. The mechanisms shall be such that the handle is in the lowered position when the switch is open and in the raised position when the switch is closed.

3. The handle shall have definite "ON" and "OFF' positions which shall be clearly labeled.

4. Provisions shall be made to secure the handle in either operating position using a single padlock.

5. The manual operator shall incorporate all components necessary for connecting to the drive pipe.

G. Motorized Operating Unit:

1. General:

a. Disconnect switches with motorized operating units shall be configured to permit remote monitoring and control by means of a SCADA System.

b. The SCADA system will remotely switch power to initiate the disconnect switch operation via interposing relays.

c. Refer to the Communications and Traction Power Systems Specifications sections of the SCADA Remote Terminal Unit (RTU) and the control cables connecting

between the RTU and the motorized operating unit. The SCADA headend equipment will be by others.

2. Power Supply:

   a. The power supply to the motorized operating unit will be 125V DC for control and monitoring.

   b. The 125V DC will be delivered from a central Wayside Power Cubicle at each interlocking.

   c. External cables and 125V DC source is not part of this Section.

   d. The motorized operating unit shall be capable of functioning correctly for a supply voltage anywhere within the ANSI specified control voltage range.

3. Motorized Operation:

   a. Push buttons shall be provided inside the normally locked operating unit for the purpose of operating the switch locally.

   b. A changeover switch shall be provided to select local or remote control. The selector switch shall also provide spare contacts for remote indication via the SCADA system.

   c. The design of the unit shall be such that once a motorized operation has been initiated, that operation will be completed.

   d. The maximum opening time or closing time shall not exceed 6 seconds during normal operating conditions.

   e. Provisions for manual operation of the motorized switch must be provided for use in case of loss of power to switch.

4. Limit Switches and Remote Indication Facilities:

   a. Limit switches, actuated according to the position of the output shaft, shall be provided as required for correct motorized operation of the disconnect switch. Additionally, 4 (four) fully reversible voltage free contacts shall be provided for the purpose of remote indication of the disconnect switch status.

   b. These contacts shall have a minimum rating of 10A @250 V.

5. Enclosures:

   a. The motorized operating units shall be housed in weatherproof (NEMA) enclosures. Surfaces shall be protected by galvanizing or, subject to agreement, by a suitable alternative treatment affording a similar degree of protection.

   b. The enclosure shall incorporate a lift-off front panel which is opened by turning a handle. The front panel shall incorporate provision for locking in the closed position.

   c. The front panel shall be interlocked with the operations handle to prevent removal when the switch is closed.

d. The enclosure shall have ventilation apertures which prevent the ingress of vermin and insects. The apertures shall be suitably louvered externally to prevent the ingress of water.

e. Provision shall be made in the base of the enclosure for the accommodation of the incoming cables.

f. The enclosure shall be designed to give easy access to all sub-assemblies by removable internal panels.

6. Anti-Condensation Heater:

a. The motorized operating unit shall incorporate a 110 V/240V AC 60Hz anti-condensation heater of suitable power rating.

7. Protection Devices:

a. Separate fuses shall be provided for the motor circuit and the control circuit.

b. For each of the three circuits referred to in Paragraph G.6.a and G.7.a, fuses shall be provided.

c. The motor circuit shall incorporate a thermal cut-out to protect the motor against overloads.

d. A system shall be incorporated to prevent the operation under excessive torque.

8. Labels:

a. Provide labels to indicate clearly whether the switch is in the 'CLOSED" or "OPEN" position.

b. A suitably inscribed plate giving instructions for manual operating shall be fixed within the operating unit enclosure in an easily read position.

9. Couplings:

a. Supply each motorized operating unit complete with all components necessary for connection of the drive pole.

10. Special Requirements:

a. The motorized operating unit shall be fitted with an internal locking device to secure the switch in either position. The locking device shall incorporate a switch which interrupts the motor circuit when the isolator is locked in either position.

b. Suitable terminal blocks for connecting all incoming cables shall be provided in an accessible position in the motorized operating unit. All internal wiring and cable terminations associated with the operating unit shall be supplied by the manufacturer.

H. Provide line and load side disconnect switch terminals furnished with silver plated copper buses complying with ASTM B187, to accommodate the number and size of copper cables as indicated on the Contract Drawings. The switch terminals shall have provision for NEMA drilled (2-hole or 4-hole) cable terminal lugs.

I. Provide each disconnect switch manual operating handle or motor operator cabinet with an outdoor type, heavy duty, keyed padlock having a hasp diameter of ½" minimum. Key all padlocks alike. Provide two (2) keys for each padlock and turn over at the completion of testing and acceptance, with all keys identified.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Field install switches on the OCS structures as shown on the Contract Drawings and specified herein. Install field mounted switches in accordance with the shop drawings. Provide brackets, bolts and support items as required, in accordance with the disconnect switch manufacturer.

B. Ensure the structural adequacy of the OCS poles for supporting the mounted disconnect switches and accessories.

C. Prior to energization of the OCS, verify correct operation of all disconnect switches installed.

D. Provide all wiring as required. Provide conductor sizes, composition and insulation as indicated on the approved disconnect switch shop drawings. Provide and install all necessary additional hardware such as bushings, connectors, cable supports, grounding conductors, and all basic electrical materials needed for the installation of the equipment and accessories.

END OF SECTION

SECTION 34 30 79

UNINSULATED CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section covers the supply and installation of uninsulated conductors and cables for the Overhead Contact System (OCS), as shown on the Contract Drawings and specified herein. This work shall include the following conductors and cables:

1. Messenger Wire
2. Contact Wire
3. Along-Track Auto Transformer Feeder Wire
4. Static Wire
5. Jumper Wire
6. Mid-Point Anchor Tie Wire
7. Hanger Wire (also referred to as Dropper Wire)
8. Cantilever Dropper Wire
9. Electrical Connection Wire

B. The Contractor shall supply and install all applicable bare conductors, cables and wires for the 25 kV AC Overhead Contact System in accordance with the requirements specified.

1.2 QUALITY CONTROL

A. The Contractor shall perform the Work included in this Section in strict accordance with Section 01400, Quality Control and Assurance.

B. The Conductor Supplier shall perform the following

1. Material qualification testing and certification for acceptance of materials, components and assemblies.
2. Job control testing of in-progress work being performed in shops, factories and on site.
3. On-site inspection of specified work elements.

1.3 REFERENCES

A. Codes and Standards: Pertinent provisions of the following listed standards shall apply:

1. American Society for Testing and Materials (ASTM)
    a. B1, Specification for Hard-Drawn Copper Wire.

b. B3, Specification for Soft or Annealed Copper Wire.

c. B8, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

d. B47, Specification for Copper Trolley Wire.

e. B105, Specification forHard-Drawn Copper Alloy Wires for Electric Conductors.

f. B173, Specification for Rope-Lay-Stranded Copper Conductors Having Concentric-Stranded Members, for Electrical Conductors.

g. B193, Standard Test Method for Resistivity of Electrical Conductor Materials.

h. B229, Specification for Concentric-Lay-Stranded Copper and Copper-Clad Steel Composite Conductors.

i. B231, Specification for Concentric Lay-Stranded Aluminum 1350 Conductors.

j. B232, Specification for Concentric Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR).

k. B258, Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors.

l. B549, Specification for Concentric-Lay-Stranded Aluminum Conductors, Aluminum-Clad Steel Reinforced for Use in Overhead Electrical Conductors.

2. European Standard (EN)

a. 50149, Railway applications. Fixed installations. Electric traction. Copper and copper alloy grooved contact wires.

3. DIN

a. 48201–2, Bronze Stranded Conductors.

1.4 SUBMITTALS (CDRL)

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. The Contractor shall submit Shop Drawings and technical data to Caltrain for review and approval prior to cable and wire manufacture. Included as a minimum shall be:

1. Physical Characteristics and Parameters

a. Size

b. Type

c. Material

d. Number of and diameter of individual wires

e. Overall diameter

f. Cross section area

g. Weight per foot

h. Rated breaking load

2. Electrical Characteristics

a. Maximum rated ampacity and temperature for each size

b. Resistance per unit length

C. The Contractor shall make available at the warehouse samples to Caltrain for review and approval for all conductors proposed for use on this project.

D. The conductor manufacturer shall provide certifications verifying that the conductors have been manufactured, inspected and tested in accordance with applicable portions of the referenced standards and the Contract Drawings for which Caltrain has issued an approval.

E. The Contractor shall provide certified copies of manufacturer's test reports for the specific conductors furnished, which shall include but not be limited to the following information:

1. Initial and Final Modulus of Elasticity (E)

2. Coefficient of Thermal Expansion (CTE)

3. Yield stress

4. Hardness values

1.5 DELIVERY, STORAGE AND HANDLING

A. Ensure that all materials furnished are suitably packaged and protected against damage during delivery and transportation.

B. Store all products in accordance with the manufacturer's instructions to ensure that all material is protected from damage and exposure.

C. Handle and otherwise use the wire and cable in accordance with the manufacturer's instructions, so as to ensure that the products are not damaged or misused prior to or during installation.

D. All repairs and replacements of damaged cables shall be in accordance with the manufacturer's instructions. Any damage to the wire and cable prior to delivery shall be the cable supplier’s responsibility.

1.6 WARRANTY

A. The conductors shall have a minimum in-service life expectancy of 40 years under operating conditions with the exception of contact wire which is dependent upon the number of pantograph passes. Therefore, the normal wear of the contact wire is an acceptable reason for its replacement prior to 40 years.

B. The conductors shall be unconditionally guaranteed by the manufacturer and/or supplier to be free from defects for a period not less than 2 years after acceptance of the Project by Caltrain.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Conductor materials shall be of a composition, quality, and purity, such that the finished product shall have the properties and characteristics described in this Section and on the Contract Drawings. All conductors shall be of uniform size and shape.

B. The bare conductor particulars shall be in accordance with the parameters indicated on the Contract Drawings.

C. Materials furnished shall be standard products of manufacturers regularly engaged in the production of the same materials specified.

2.2 BARE CONDUCTOR

A. The work specified in this Article includes furnishing the main OCS conductors such as messenger wire, contact wire, jumpers, feeder wires, shunt wire, static wires, hanger wire, electrical connection wire, and cantilever dropper wires as shown on the Contract Drawings and specified herein.

B. All material shall be of such composition, quality that the finished product will have the properties and characteristics described in this specification and on Contract Drawings.

1. Contact Wire: Grooved hard drawn copper AC 107 Cu-Ag conforming to EN 50149 and the following requirements:

    a. Diameter: 0.484 in (12.3 mm)

    b. Shape: AC 107

    c. Material: Cu-Ag 01

    d. Minimum breaking load: 8519 lbs (37.45 kN)

2. Messenger Wire: Stranded Bronze Bz ll 70/19 bare conforming to DIN 48201 and the following requirements:

    a. Overall Diameter: 0.413 in (10.5 mm)

    b. Nominal Cross Sectional: 70 mm2 Calculated: 0.1 in (65.81 mm2)

    c. Strand Wires: 19

    d. Material: Bz ll

    e. Minimum breaking load: 8687 lbs (38.64 kN)

3. Autotransformer (AT) Feeder Wire: Aluminum conductor, steel reinforced (ACSR) "Eagle" 556.5 KCMIL conforming to ASTM B232 and the following requirements:

    a. Overall Diameter: 0.953 in

    b. Material: Aluminum / Steel

c. Wires: Stranding - 30/7 (Aluminum/Steel)

Diameter – 0.1362 in / 0.1362 in (Aluminum/Steel)

d. Minimum breaking load: 27800 lbs

4. Static Wire: Aluminum conductor, steel reinforced (ACSR) "Penguin" 4/0 AWG conforming to ASTM B232 and the following requirements:

a. Overall Diameter: 0.563 in

b. Material: Aluminum / Steel

c. Wires: Stranding - 6/1 (Aluminum/Steel)

Diameter – 0.1878 in / 0.1878 in (Aluminum/Steel)

d. Minimum breaking load: 8350 lbs

5. Gantry to Gantry feeder wire shown on Contract Drawings all aluminum conductor (AAC) "Nasturtium" 715.5 kcmil conforming to ASTM-B231 and the following requirements:

a. Overall Diameter: 0.975 in

b. Material: Aluminum

c. Wires: Stranding – No. of Wires 61

d. Minimum breaking Load: 13100 lb

6. Shunt Wire: Aluminum conductor, steel reinforced (ACSR) "Dorking" 190.8 KCMIL conforming to ASTM B232 and the following requirements:

a. Overall Diameter: 0.63 in (16.0 mm)

b. Nominal Cross Sectional: 0.237 in2 (152.81 mm2)

c. Material: Aluminum / Steel

d. Wires: Stranding - 12/7 (Aluminum/Steel)

Diameter – 0.1261 in / 0.1261 in (3.2 mm / 3.2 mm) (Aluminum/Steel)

e. Minimum breaking load: 18700 lbs (83.21 kN)

7. For additional requirements for hanger, cantilever droppers, electrical connection wire, and jumper wires refer to OCS Basic Design Assemblies Drawing W6001.

2.3 PERFORMANCE

A. The physical, mechanical and electrical properties of the conductors shall conform to the requirements of the Contract Drawings and the pertinent provisions of all Standards referenced in this Section.

B. Joins shall be permitted in drawing stock or intermediate rod stock as indicated in EN 50149: 2001 Clause 4.8, except no joins shall be made in completed wire.

C. Wire manufacturer shall preform conformity verifications as indicated in EN 50149 during production of messenger and contact wires.

2.4 INSPECTION AND TESTING

A. Caltrain reserves the right to witness the manufacture, testing and packing of all conductors. The conductor/cable manufacturer shall notify the Contractor not less than 20 days in advance of manufacturing and testing operations.

B. All conductors shall be subject to factory quality control tests as required in the applicable Standards. Tests shall be performed on each reel prior to shipment in addition to other specified submittals; certified copy of the test report for each reel shall be submitted prior to shipment. A copy of the test report shall be packed with each reel.

2.5 PACKAGING AND MARKING

A. All conductors shall be shipped on steel reels (unless otherwise approved by Caltrain) suitable for the weight of the conductors shall be protected from damage. The diameter of the reel shall be subject to the Caltrain's approval and shall be sufficiently large to eliminate difficulty with wave or kinks when the conductor is strung. The grooved contact wire shall be wound on the reel in such manner that the vertical axis of cross section shall be parallel to the axis of the reel (i.e., the wire shall lay on its side).

B. Each reel shall consist of one continuous conductor, and shall have the required length of conductor so that no field (external) splices are required in the tension sections as installed.

C. Each reel shall have a strong, weatherproof tag or marker securely fastened to it, showing the size and type of conductor as well as the ASTM designation, name and mark of the manufacturer, total reel length and weight and manufacturer's special instructions.

D. Factory splices in contact wire stock shall be marked with paint or dye prior to wire drawing. The marks shall be readily distinguishable after the wire drawing process.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Conductor installation shall be in accordance with Section 34 30 85, OCS Installation.

B. Installation of cables shall be as shown on the Contract Drawings. Ends of stranded wires shall be enclosed inside termination crimp connectors or otherwise secured to prohibit exposed frayed ends.

END OF SECTION

SECTION 34 30 80

INSULATED CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SCOPE

A. This Section includes the furnishing, installation and testing of cables, terminations, and other materials associated with the 46 kV EPR 100% insulation Autotransformer feeder cables and surge arrester cable as shown on the Contract Drawings and specified herein.

1.2 REFERENCES

A. All cable furnished under this Section shall be in accordance with the latest applicable standards of the IEEE, ANSI, NFPA, NEMA, ICEA, AEIC, and UL with regard to material, design, construction, and testing. The standards applicable shall include, but not be limited to, the following:

1. Association of Edison Illuminating Companies (AEIC):

    a. CS8, Specification for Extruded Dielectric Shielded Power Cables Rated 5 through 46 kV.

2. American Society for Testing and Materials (ASTM):

    a. B1, Specification for Hard-Drawn Copper Wire.

    b. B2, Specification for Medium-Hard-Drawn Copper Wire.

    c. B3, Specification for Soft or Annealed Copper Wire.

    d. B8, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

    e. B33, Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.

    f. B189, Specification for Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes.

    g. B496, Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.

    h. D3005, Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.

3. Institute of Electrical and Electronics Engineers (IEEE):

    a. 48, Standard Test Procedures and Requirements for High-voltage Alternating Current Cable Terminators.

b. 82, IEEE Standard Test Procedure for Impulse Voltage tests on insulated Conductors.

c. 400, IEEE Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems.

d. 404, Standard for Cable Joints for Use with Extruded Dielectric Cable Rated 5,000 Volts through 46,000 Volts.

e. 532, IEEE Guide for Selecting and Testing Jackets for Underground Cables.

f. 576, IEEE Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications.

g. 837, Standard for Qualifying Permanent Connections Used in Substation Grounding.

h. 1210, Standard Tests for Determining Compatibility of Cable-Pulling Lubricants with Wire and Cable.

i. 1202, Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies.

j. 1235, IEEE Guide for the Properties of Identifiable Jackets for Underground Power Cables and Ducts.

4. National Electrical Manufacturers Association (NEMA):

a. WC 26, Bi-national Wire and Cable Packaging Standard.

b. WC 70, Standard for Nonshielded Power Cables Rated 2,000 Volts or Less for the Distribution of Electrical Energy.

c. WC 71, Standard for Nonshielded Cables Rated 2,001-5,000 Volts for Use in the Distribution of Electrical Energy.

d. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission & Distribution of Electric Energy.

5. National Fire Protection Association (NFPA):

a. 70, National Electrical Code (NEC)

6. Underwriters Laboratories (UL):

a. 44, Thermoset-Insulated Wires and Cables.

b. 83, Thermoplastic Insulated Wires and Cables.

c. 510, Insulating Tape.

d. 1072, Medium-Voltage (Type MV) Solid-Dielectric Cables.

e. 1581, Reference Standards for Electrical Wires, Cables and Flexible Cords.

7. Federal Specifications (FS):

a. HH-I-553, Insulation Tape, Electrical (Rubber, Natural and Synthetic).

1.3 QUALITY ASSURANCE

A. Cable Manufacturers' Qualification: Not less than fifteen (15) years of demonstrable experience in the production of the specified products.

B. Workmanship shall conform to the best modern practices in the manufacturing of a rugged, durable, and safe product for use in a public transportation system. Materials used shall be new and of the highest commercial grade as specified.

C. The Insulated Cable shall be manufactured and tested under the control of a Quality Assurance system that conforms to the requirements of ISO 9000.

D. The Quality Assurance system shall demonstrate conformance to the above criteria by having passed yearly quality audits conducted by outside independent organizations.

1.4 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. The Contractor shall submit the following for review and approval of Caltrain at various stages of planning, manufacturing, and installation of cable and wire as requested:

1. Descriptive literature, catalog data, and other pertinent information for cable sufficient to clearly demonstrate compliance with the Contract Documents. Product shall consist of manufacturer's standard catalog cuts, descriptive literature and diagrams, in 8½ X 11-inch format, and in sufficient detail so as to clearly indicate compliance with all specified requirements and standards. Submit catalog cuts for the following as a minimum:

a. Wires and cables for each type and size.

2. As-built lengths of all cable installed under this Contract.

3. Manufacturer's Certification: Manufacturer shall submit signed certification confirming that they comply with the qualifications requirements and shall provide evidence of experience upon request.

4. Product Certification: Signed by manufacturer certifying that products comply with the specified specification requirements.

5. Report of Field Tests: Certified copies of field tests.

6. 24-inch long samples of the final assembled cables for First Article Inspection prior to release.

7. Submit certified shop test reports for wires and cables.

8. Submit field test results for wires and cables, including megger readings with the method used.

PART 2 - PRODUCTS

2.1 GENERAL

A. The cable shall be suitable for use in wet and dry locations in underground duct systems and aerial applications. The cable shall be rated no less than 90° C for normal operation, 130° C for emergency overload condition and 250° C for short circuit conditions. Emergency overload operation may occur for periods up to 100 hours per year and with as many as five (5) such 100-hour periods within the lifetime of the cable.

B. Water-based, gel-type, high-performance cable-pulling lubricants shall be utilized in accordance with cable manufacturer recommendations.

2.2 INSULATED AUTOTRANSFORMER (AT) FEEDER CABLE

A. Electrical Ratings:

1. Single-conductor cable for the 27.5 kV nominal overhead contact system cables shall be rated for no less than 46 kV class line-to-line voltage rating basis described in NEMA WC 74.

B. Conductor:

1. Copper conductor, annealed, uncoated and Class B stranded, per ASTM B-8 for compressed round stranded, and ASTM B496 for compact round stranding.

2. Conductor sizes shall be 750 kCMIL for aerial AT feeder cable.

3. For portions of AT feeder cable installed in a ductbank, the contractor may utilize 1250 kCMIL, 46 kV cable per Specification Section 34 31 86 (under future development).

C. Conductor Screen:

1. The strands shall be completely shielded with a layer of semi-conducting extruded ethylene propylene rubber material compatible with the insulation. The compound shall have a maximum volume resistivity of 1000 ohm-meters at 105° C and a minimum elongation of 100 percent after an air oven test at 136° C for 168 hours. The strand shielding shall be in intimate contact with the strands and shall be completely free- stripping from the strands.

D. Insulation:

1. The insulation for 750 kCMIL and 1250 kCMIL cables shall consist of thermosetting Ethylene Propylene Rubber (EPR) which will meet the requirements of the referenced AEIC and NEMA specifications with the additional requirements listed below. The ethylene content of the elastomer used in the insulation compound shall not exceed 72 percent by weight nor shall the insulation compound contain any polyethylene. The insulation shall be compounded and extruded in a closed system to insure maximum cleanliness.

2. The insulation shall be circular in cross-section, and so centered that the minimum wall thickness shall be not less than 90 percent of the average thickness specified.

3. 46 kV class cables: Insulation thickness shall be in accordance with NEMA WC 74 Table 4-1 for a 100 percent insulation level (between 430 and 495 mils).

E. Insulation Screen:

1. The insulation shall be completely shielded with a layer of extruded semi-conducting ethylene propylene rubber compound. The compound shall have a maximum volume resistivity of 500 ohm-meters at 90° C and a minimum elongation of 100 percent after an air oven test at 136° C for 168 hours. It shall be in intimate contact with the insulation and shall be stripped with four to twenty-four pounds of tension per ½-inch wide strips at room temperature. The legend "SEMI-CONDUCTING SHIELDING, REMOVE BEFORE SPLICING OR TERMINATING" shall be printed in white indelible non-conducting ink along its entire surface.

F. Metallic Shield:

1. The insulation screen shall be shielded with a 5-mil tin-coated copper tape helically applied with a minimum overlap of not less than 20 percent. A longitudinal corrugated copper shield of equal or higher thickness will also be acceptable.

2. A sufficient number of concentric neutral conductors shall be applied over the metallic tape so that the combined conductivity of the tape and wire shields shall be at least 33 percent of the conductivity of the phase conductor.

3. The concentric conductors shall be No. 14 or No. 12 AWG bare, uncoated copper. They shall be evenly spaced and helically applied over the copper tape with a lay of not more than 12 times the cable diameter measured over the concentric conductors.

G. Jacket:

1. Black extruded flame retardant, low-smoke/zero halogen (LS/ZH), thermoplastic, polyolefin (TPPO) jacket.

2. Jacket and jacket thickness shall be in accordance with NEMA WC 74 and AEIC CS8 for 46 kV class cables.

H. Messenger:

1. Messenger shall be ½ inch diameter, extra high strength seven strand galvanized wire. The messenger shall be lashed to the 46 kV cable with stainless steel binder tape.

I. Conductor Sizes:

1. 750 kCMIL Aerial Feeder Cable: as shown on the Contract Drawings.

2. 1250 kCMIL Ductbank Feeder Cable

   a. Diameter: 2.213 in (56.21mm) O.D.

   b. Nominal Cross Section: 0.98 in2(633mm2)

c. Material: Copper

d. Strand Wires: 91

e. Minimum breaking load: 56,280 lbf (250.3 kN)

2.3 SURGE ARRESTER GROUNDING CABLE

A. Electrical Ratings:

1. Surge arrester grounding cables shall be rated no less than 2.4 kV.

B. 2.4 kV Rated Grounding Cable for Surge Arresters:

1. The conductor shall be 4/0 AWG Class B compressed stranded bare copper per ASTM B3 and ASTM B8

2. Conductor shield shall be Semi-conducting cross-linked copolymer.

3. Insulation shall be Cross Linked Polyethylene (XLPE):

C. Conductor Sizes:

1. 4/0 AWG Grounding Cable for Surge Arresters

a. Diameter: 0.764 in (19.4mm) O.D.

b. Nominal Cross Section: 0.1659 in2 (107mm2)

c. Material: Copper

d. Strand Wires: 19

e. Minimum breaking load: 1,693 lbf (7.5 kN).

2.4 CABLE IDENTIFICATION AND LABELING

A. The following information shall be printed on jacket, using contrasting indelible color ink, at intervals per NEMA WC 70, WC 71 and WC 74 as applicable:

1. The words: "Property of Caltrain"

2. Manufacturer's name and plant, and year of manufacture

3. Conductor size and material

4. Voltage rating

5. Insulation type and thickness (mils)

6. Jacket type and thickness (mils)

7. Percent insulation level

8. UL designations (where applicable)

9. Other appropriate conductor information

2.5 TERMINATING AND ARC-PROOFING MATERIALS

A. Terminating shall be as specified in this Section. Details of terminating shall be as shown on the Plans or in accordance with manufacturer's recommendations. Any terminating methods other than those specified below, for which the components are in accordance with the requirements of this Section, shall be submitted for approval.

B. Splices shall not be permitted.

C. Cable termination fittings and lugs shall be compatible with the feeder cable and the switchgear, disconnect switch, or impedance bond to which the terminations are being made.

D. Connectors: Subject to compliance with requirements of this Section, provide connectors of the following types:

1. Solder-less, uninsulated, high-conductivity, corrosion-resistant, compression connectors conforming to UL 467 and IEEE 837.

2. Insulated, indenter-type compression butt connectors.

3. Insulated, integral self-locking flexible shell, expandable spring connectors.

4. Uninsulated, indenter-type compression pigtail connectors.

5. Welded-type connectors.

E. Terminals: Subject to compliance with requirements of this Section, provide terminals of the following types:

1. Solder-less, uninsulated, high-conductivity, corrosion-resistant, compression terminals conforming to UL 467 and IEEE 837.

2. Insulated, compression terminals.

3. Solder-less, high-conductivity, corrosion-resistant, hex screw-type, bolted terminals.

4. Welded-type terminals.

5. Medium-Voltage Cable Terminators:

a. Shall consist of a factory-engineered kit and copper connector specifically designed for the terminating of the associated shielded cable in an outdoor location. Terminator shall be rated 46 kV, with an ac withstand one minute-voltage of 120 kV. Kit shall meet IEEE 48, Class 1 requirements, and be capable of passing the appropriate test sequence of IEEE 404. Kits shall provide for the grounding of the cable shield without the use of special construction.

b. Shall consist of heat-shrinkable stress control and outer non-tracking insulation tubing and outer skirts. Terminals shall be all copper, of high-conductivity, corrosion-resistant type, conforming to UL 467. Terminating kits shall be Raychem, or approved equal, and connectors shall be Burndy, or approved equal.

F. Shrinkable Tubing: Subject to compliance with requirements of this Section, provide shrinkable tubing of the following types:

1. Either irradiated modified polyvinyl chloride or irradiated modified polyolefin heat shrinkable tubing;

2. Cold shrinkable tubing.

G. Tapes and Sealers:

1. Vinyl Tapes: Flame retardant, cold and weather-resistant, 3/4-inch or 1-1/2-inches wide, as required, and conforming to UL 510 and ASTM D 3005.

a. For interior, dry locations, provide seven mils, conforming to ASTM D 3005 (Type 1); Scotch (3M) No. 33, or approved equal.

b. For exterior or damp and wet locations, provide 8.5 mils, conforming to ASTM D 3005 (Type II); Scotch (3M) No. 88, or approved equal.

2. Rubber Tapes: Ethylene propylene rubber based, 30 mil splicing tape, rated for 130°C operation; 3/4-inch and wider (1, 1-1/2, 2-inches) as shown on the Plans or approved by Caltrain, conforming to ASTM D 1373 and FS HH-I-553 (Grade A); Scotch (3M) No. 130°C, or approved equal.

3. Insulating Putty: Rubber based 125 mil, 130°C rated, anti-tracking, self-fusing tape; one-inch wide; Scotch (3M) No. 70, or approved equal.

4. Silicone Rubber Tapes: Inorganic silicone rubber, 12 mil, 130°C rated, anti-tracking, self-fusing tape; one-inch wide; Scotch (3M) No. 70, or approved equal.

5. Sealer: Liquid-applied, fast-drying sealant; Scotch (3M) Scotchkote, or approved equal.

PART 3 - EXECUTION

3.1 CABLE SHIPPING, STORAGE, AND HANDLING

A. Cable shall be packaged in accordance with NEMA WC 26 and the requirements stated herein. Protective reel coverings shall be Level 3 or greater in accordance with NEMA WC 26.

B. Insulated Cable for this design package shall be furnished in accordance with the Plans and with the following requirements. The Contractor is responsible for cable shipment, storage, and security.

1. All traction power cable for this contract shall be shipped freight on board (FOB) site to Contractors designated storage area - unless cable is part or spare or surplus materials. Cable shall be shipped on reels with protective covering, including wooden lags, commensurate with the weight of the loaded reel.

2. A watertight seal shall be applied to each end of the cable to prevent moisture ingress during shipment or outdoor storage. The Contractor shall provide factory-applied caps to wire and cable sizes No. 4/0 AWG and larger unless otherwise shown on the Plans. End seals shall be heat-shrink, irradiated, modified polyolefin, and shall be sized for individual wires and cables.

3. A durable, weatherproof label shall be securely attached to the outside of both flanges of each reel. Each label shall indicate the following:

    a. Purchase order number

    b. Name and address of manufacturer

    c. Reel number

    d. Total length of cable on reel

    e. Description of cable

    f. Tare and total weight of reel and rolling direction

C. The Contractor shall ensure that single conductor wire or cable sizes No. 4/0 AWG and larger that are to be installed in the same raceway are paralleled by the cable manufacturer before shipment. Cable assembly overall diameter shall be kept to a minimum.

3.2 INSTALLATION REQUIREMENTS

A. Keep wires and cable dry at all times. Cable ends shall be properly sealed before stringing cable. Cable ends shall not be left with insulation exposed after cutting unless splicing is to be performed immediately. Before terminating wires and cables, make a thorough inspection to determine that water has not entered the wires and cables or that the wires and cables have not been damaged.

B. Strip all nails from outside edges of reel heads before stringing of cable. Conveniently locate reels for stringing cable without excessive bending or possible injury to cable by abrasion. Reels shall be jacked to clear ground level or obstructions by at least six (6) inches before stringing of cable.

C. Where the aerial insulated autotransformer feeder cable is installed in conduit, the messenger and messenger lashing shall be removed prior to installation.

D. For additional Traction Power Underground and Ductbanks installation requirements see Specification Section 34 31 23 (under future development).

3.3 CABLE WARRANTY

A. The Contractor shall replace any length of cable installed by the Contractor which fails during normal use within one year of Contract substantial completion, provided immediate written notice of such failure is given to the Contractor with all reasonable opportunity provided thereto to inspect such failure.

B. The date of placing into service shall be interpreted as the date on which operating voltage is first continuously applied to the completed cable installation.

3.4 INSPECTION AND TESTING

A. Inspection: Caltrain reserves the right to witness the manufacture, testing, and packaging of all conductors. The Contractor shall notify Caltrain not less than ten (10) days in advance of manufacturing and testing operations.

B. Testing: The standard dielectric-withstand tests shall be performed on each reel of cable prior to shipment. A certified copy of the test report for each reel of cable shall be furnished to Caltrain prior to shipment. A copy of the test report shall also be packed with each reel. Test requirements shall be in accordance with NEMA WC-70, WC-71 and WC-74 as applicable.

C. Submit samples not less than twenty-four (24) inches in length, with five (5) copies of the notarized certified test reports of each type and size of wire and cable to be furnished for First Article Inspection prior to release.

3.5 SHOP TESTS

A. For quantities as shown on the Plans, regular dielectric-withstand and insulation resistance in water tests for wires and cables shall be performed in accordance with the referenced standards.

B. Flame tests for wires and cables shall be performed in accordance with vertical tray flame test of UL 1581 F. Cable sizes larger than 1/0 AWG shall meet the vertical tray flame test requirements of IEEE 1202.

C. The test results shall be certified for each reel/coil/box of wire or cable.

D. Factory inspection and witnessing of tests by Caltrain may be required for all wires and cables furnished under this Contract. Caltrain reserves the right to require additional testing, or to waive factory inspection or witnessing of tests. The Contractor shall notify Caltrain fourteen (14) days in advance of the scheduling of such factory tests.

3.6 FACTORY CABLE TESTS (FULL LENGTH)

A. Tests conducted at the factory shall include, but not be limited to, the following standard tests per NEMA WC 70, WC 71 and WC 74, as applicable, for the entire completed cable:

1. Insulation Resistance Tests: performed in accordance with the requirements of the referenced standards. Each cable shall have an insulation resistance not less than that corresponding to the insulation resistance constant of at least 50,000 megaohms per 1,000 feet at 15.6°C.

2. Shield Resistance: measured and recorded from end to end on the completed cable.

3. Corona Test: Each reel of completed shielded power cable shall comply with the maximum partial discharge in pico-coulombs. The partial discharge test shall be performed in accordance with the procedures of AEIC CS8 and CS9 and an X-Y recording graph will be furnished showing the corona test results.

4. Water Block Test: A water penetration production test for filled strand cable construction shall be performed on each master length of insulated conductor.

5. Flame Test: Flame Test shall be performed in accordance with the referenced standards.

3.7 FIELD TESTS

A. Inspect wires and cables at terminations for physical damage and proper connection.

B. Verify continuity of each circuit conductor.

C. All feeder cables shall be Hi-pot tested to NETA and the test report shall be submitted for approval. Furnish Caltrain with a copy of the megger readings together with an outline of the method used. If, in the opinion of Caltrain, any reading is lower than that required by applicable codes, promptly replace the materials involved, at Contractor's expense, and retest.

D. Cables shall be subjected to Acceptance Tests as specified below to ascertain that the dielectric strength of the cable insulation has not been impaired during installation, that the splices and terminations are properly made and to confirm the integrity of the cable system prior to energization. These shall include continuity tests and insulation resistance tests performed after the cable installation.

E. Acceptance Tests: After installation of the entire length of cable, the Contractor shall perform the tests listed below on each cable in accordance with the Acceptance Testing Specifications of the National Electrical Testing Association (NETA). To preclude damage to equipment and devices, the tests shall be conducted before the cable is terminated at electrical equipment. If terminations have already been made, cables shall be disconnected from the equipment for testing and shall be reconnected after completion of tests.

1. Dielectric Test:

    a. This test shall be performed to ensure that the cable insulation has not been impaired during installation.

2. Continuity Test:

    a. This test shall be performed to prove the continuity of the conductor.

3. Insulation Resistance Test:

    a. This test shall be performed to determine the cable insulation resistance to ground.

    b. Megger test voltage shall be applied between the conductor and ground and shall be held until the reading reaches a constant value for five (5) minutes. Insulation resistance values obtained by the megger tests shall not be less than two megaohms at 1,000 V. Contractor shall bring to the attention of Caltrain the results of similar tests having unequal readings with the variations of twenty-five (25) percent or more.

    c. For each test, the Contractor shall record the temperature, humidity and duration of the test.

F. Defective Cables:

1. Cable conduits shall be sealed after testing and final connection of cables. Any cable installed under this Contract found defective during the testing shall be replaced with new cable at the expense of the Contractor.

END OF SECTION

SECTION 34 30 85

OCS INSTALLATION

PART 1 – GENERAL

1.1 SUMMARY

A. This Section specifies the installation requirements of the Overhead Contact System (OCS), which is broadly defined as those conductors, and related items, forming the overhead power distribution system, and comprises the messenger and contact wires, ancillary pull-offs and backbones wires, hangers, feeder cables, jumpers, sectioning devices, cross spans and head spans, tensioning units and systems, and ground connections, together with their related supports, hardware, equipment and insulation.

B. Coordinate the OCS installation with the staging and interface requirements as set forth in the Section 34 30 06, Interface Requirements. The Contractor shall submit detailed plans for all proposed temporary anchorages, guying, electrical isolation and protection required to turn over discrete sections of the system to Caltrain for its use as required in Section 34 30 03, OCS General Requirements.

C. Coordinate electrical and service outage requirements for connecting new adjacent sections of the OCS to those sections of OCS previously energized.

1.2 QUALITY CONTROL

A. Perform the Work included in this Section in strict accordance with the requirements of Section 01400, Quality Control and Assurance.

1.3 REFERENCES

A. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering, 2014, Chapter 33 Electrical Energy Utilization

B. European Committee for Electrotechnical Standardization (CENELEC) Standards

1. EN 50119, 2001, Electric Traction Overhead Contact Lines

2. EN 5022-1 Part 1, 1998, Protective Provisions Relating to Electrical Safety and Earthing

3. EN 50124-1, 2001, Insulation Coordination: Part 1 – Basic Requirements

4. EN 50149, 2001, Electric Traction: Copper and Copper Alloy Grooved Contact Wires

5. EN 50317, 2002, Railway applications: Current collection systems - Requirements for and validation of measurements of the dynamic interaction between pantograph and overhead contact line

C. California Code of Regulations (CCR) Title 8, Division 1, Chapter 4, Subchapter 5: Electrical Safety Orders

D. California Public Utilities Commission (CPUC) General Orders (GOs)

1. CPUC GO 26-D, 1981, Regulations Governing Clearances on Railroads and Street Railroads with Reference to Side and Overhead Structures, Parallel Tracks, Crossings of Public Roads, Highways, and Streets

2. CPUC GO 95, 2014, Rules for Overhead Electric Line Construction

3. CPUC GO 143-B, 2000, Safety Rules and Regulations Governing Light Rail Transit

4. CPUC Resolution SED-1.

PART 2 – PRODUCTS

Not applicable.

PART 3 – EXECUTION

3.1 OCS INSTALLATION TOLERANCES

A. Contact Wire Stagger

1.	Open Route	± 1 inch
2.	Bridge-Resilient Arms	0.5 inch

B. Contact Wire Height

1.	Mainline installation tolerance	-0 inch, + 1 inch
2.	Mainline vertical tolerance height	-0 inch, + 1 inch
3.	Yard	-0 inch, + 1 inch
4.	Bridge resilient arms	-0 inch, + 0.5 inch

5. Contract wire height through transitions shall follow maximum design gradient within the transition and half this value for two consecutive spans. Contact wire height difference between two consecutive spans, on flat levels shall not exceed half the maximum design gradient corresponding to the speed limit.

6. Contact wire staggers shall be relative to track centerline.

C.	Messenger Wire/Contact Wire Offset	± 2 inch
D.	Hanger Location along track tolerances	± 3 inch
E.	Hanger Length	± .25 inch
F.	Hanger verticality	± 0.5 inch
G.	Cantilever Setting Tolerance (cross track)	± 3 inch

3.2 INSTALLATION OF OCS COMPONENTS

A. Insulators, Hardware, and Connectors: Install in accordance with manufacturer's instructions.

B. All OCS supporting devices including steady arms, messenger supports and cross-span or wire pull-off/backbone registration assemblies shall be installed as shown on the shop drawings.

C. All connections, bolts, and nuts shall be properly torqued in accordance with the torques shown on the shop drawings and component drawings.

D. All items shall be inspected for form, function and fit, including damaged coatings or bent/kinked members. Any piece found to be defective shall be rejected and a replacement shall be installed at the Contractor's expense.

E. Cantilevers shall be installed as shown on the shop drawings. Take field measurements prior to cantilever fabrication, to determine the as-built dimension from centerline of track to face-of-pole at either contact wire height or messenger wire height. Due allowance shall be made, during cantilever fabrication, for dead load (static) deflection of the pole.

F. For stability during stringing, the cantilevers shall be temporarily restrained to prevent collapse due to swinging. The details of the temporary restraints shall be submitted for Caltrain's review and approval.

G. Cotter pins and nuts on each cantilever shall be located on the same side of the structure at the side that has the maintainer facing oncoming traffic to assure uniformity along the line, ease of maintenance, and safety.

H. Assemblies fitted with pins, cotters, bolts and nuts shall be oriented where possible in such a manner as to lock these components together by gravity if the pins or nuts should, for some reason, become detached under service conditions.

I. Components employing a hinge or swivel shall be lubricated with grease before assembly of the rubbing surfaces, if so recommended by the OCS material suppliers. Grease product shall be subject to Caltrain's review and approval.

J. All conductors shall be brushed and greased prior to the application of current carrying clamps and connectors. Aluminum to aluminum or aluminum to copper contact surfaces shall be coated with "Burndy" Penetrox A or Alnox compound or equal. Copper to copper contact surfaces shall be treated with "Burndy" Penetrox E compound or equal.

K. When aluminum to copper contact surfaces require to be in contact to prevent copper corrosion, add bi-metallic couplings and orientate products to be rain-washed on their exposed surfaces.

3.3 INSTALLATION OF CANTILEVERS

A. The types of cantilever and registration assemblies to be installed on each pole or support shall be as indicated on the OCS Layout and Material Allocation Drawings.

B. The along-track offset of the cantilever on completion shall be in accordance with its distance from the midpoint anchor for the prevailing temperature.

C. After installation of cantilevers and stringing of conductors, adjustment may be required to the stagger, heel setting, and contact wire height and cantilever inclination to be within the specified design tolerances.

D. All clamps and connectors shall be installed in accordance with the manufacturer's instructions including torque applications for bolted type connectors.

E. Compression or wedge type connectors shall be installed according to the manufacturer's recommended orientation and instructions.

3.4 INSTALLATION OF BALANCE WEIGHT ANCHOR (BWA) AND MID-POINT ANCHOR (MPA)

A. Install BWA assemblies as indicated on the Contract and Shop Drawings. All wire rope shall be non-rotational stainless steel.

B. The MPA assembly for each wire run must be fully installed prior to the installation of the respective auto tensioning devices.

C. Auto tensioning devices shall be installed at elevations and locations as indicated on the Contract and/or Shop Drawings.

D. The type of balance weight assembly at each location shall be as indicated on the Contract Documents.

E. A general chart, showing BWA assembly height tolerances, which refers to a reference levels for various wire temperatures and tension lengths shall be included on the Contract and/or Shop Drawings.

F. Auto tensioning devices shall be free moving between conductor temperatures as shown on related Contract Drawings.

G. Special care shall be taken during installation of auto tensioning devices to obtain correct wire temperature and travel clearance for the balance weight and pulley assemblies. Preliminary prestressing of the OCS to remove creep shall be completed prior to finalization of the balance weight settings. Submit prestressing procedure for Caltrain approval. Prestressing is not required if cables installed at full tension using wire trains.

H. Auto tensioning devices shall be suitably adjusted to provide the required weight and operational range as shown on the Contract Drawings.

I. An approved lubricating grease shall be applied to hinges, guideways and guide rods.

3.5 INSTALLING HANGERS

A. Prior to fabricating and installing OCS hangers, record the as-built OCS span lengths. Hanger lengths shall be calculated, fabricated and installed to suit the as-built span lengths, rounded to the nearest foot.

B. Perform field adjustments of hangers, messenger and contact wire heights as necessary to maintain the OCS in compliance with the Contract Documents.

C. Wire stagger, wire height, and heel settings shall be in accordance with the Contract Documents.

D. Space hangers (in the along-track direction) as indicated on the Contract Documents within a tolerance of +/-3".

E. Any damage to the interfacing components during installation shall be replaced or repaired.

3.6 INSTALLATION OF HEADSPAN AND CROSS-SPAN ASSEMBLIES

A. Prior to installation of headspan or cross-span assemblies, record the following field details and measurements of each headspan and cross-span locations:

1. Pole to pole, track to track, and track to pole centerline dimensions

2. Relative cross-track elevation of tops of foundations and tracks

3. Track super-elevations and direction facing towards higher station numbers

B. Attachment heights and loadings for cross-spans and headspans shall be fully developed in accordance with the Contract Documents.

C. Wire sizes, locations of turnbuckles, insulators, suspension assemblies, and hangers for the OCS shall be installed in accordance with the Contract Drawings.

3.7 STAINLESS STEEL WIRE AND WIRE ROPE

A. Stainless steel wire and wire rope shall be used as shown on the Contract Drawings.

B. The cut ends of stainless steel wire rope shall be enclosed inside crimp sleeves or otherwise band with wire to secure all exposed ends.

3.8 INSTALLATION OF DOWN GUYS AND AERIAL HEAD GUYS

A. Install down guys and aerial head guys before the OCS conductors are installed. Pulled taut, and secured in place with provisions for future adjustment as required to support the OCS structure in proper alignment after the OCS conductors are installed to their final configuration and tensions.

B. Install down guy and aerial head guy terminations and attachments as recommended by the Manufacturer.

C. Install guy guards as indicated on the approved shop drawings , or as deemed necessary in the field to protect the public and/or the Caltrain maintenance workers from any potential danger imposed by the guy wires.

D. Make all final adjustments necessary to the down guys and aerial head guys to compensate for initial stretch to insure the proper long-term support and alignment of the OCS wires.

3.9 INSTALLATION OF PULLOFF AND BACKBONE WIRES

A. Install backbone wires and pull-offs before the OCS wires are installed. Provide wires of the correct length and secured in place with provisions for future adjustment as required to register the OCS structure in the proper horizontal alignment after the OCS wires are installed to their final configuration and tensions.

B. Install pull-off assemblies as indicated on the Contract Drawings to hold the OCS system in its correct horizontal alignment on curves prior to tensioning.

C. Make all final adjustments necessary to the backbone wires to compensate for initial stretch to insure the proper long-term support and alignment of the OCS wires.

3.10 INSTALLATION OF SECTION INSULATORS

A. Install section insulators as indicated on the Contract Drawings and Shop Drawings.

B. All electrical connectors and clamps are to be prepared and protected externally and internally in accordance with the manufacturer's recommendations.

C. The method of installation shall assure there is no damage to the OCS conductors. Repair or replace any kinked contact wire in accordance with the Contract Documents.

D. Maintain and adjust all new section insulators to provide for smooth passage of the pantograph and uninterrupted current collection by the pantograph until such time the OCS is accepted.

3.11 STRINGING OF CONDUCTORS

A. All conductors shall be installed in accordance with good railroad OCS practice and overhead line practice, and the manufacturers' recommendations. Conductor creep shall be considered in tensioning messenger and contact wires except if stringing is at full tension by a wire train. Prepare and submit procedures for this item.

B. Conductor tensions, cantilever settings, and auto tensioning assemblies are temperature related. During stringing, actual conductor temperatures as measured by contact thermometers shall be used in conjunction with the stringing charts to ascertain the various stringing parameters. Laser or infrared temperature guns shall not be used to record conductor temperatures without specific prior approval by Caltrain.

C. Messenger and contact wires shall not be spliced without specific prior approval by Caltrain. When required for construction, obtain Caltrain's approval and install full tension wire splices.

D. Splices in feeder and static wire conductors shall comply with the following conditions:

1. In general, there shall not be more than one splice per conductor per mile.

2. Splices shall be located at least 25 feet away from poles.

3. Splices shall not be permitted at grade crossings and at underbridges.

E. Care shall be taken to avoid kinks in the wires. Destranding (birdcaging) of stranded conductors shall be prevented. Kinks in the contact wire shall be avoided.

F. The contact wire shall be free of twists from anchor clamp to anchor clamp.

G. Termination fittings shall be oriented in accordance with the Contract and Shop drawings.

H. Prior to energization, conductors may be grounded during and after the stringing process as required or identified by Caltrain.

3.12 PRECAUTIONS IN HANDLING CONDUCTORS

A. All conductors shall be handled in such a manner that they will not be scratched, cut, or nicked with tools or clamps.

B. Conductors shall not lie upon, or be dragged across, sharp or rough surfaces (such as the track or ground).

C. Conductors which are, or become, annealed shall be replaced without exception.

D. Kinks or sharp bends shall not be put in the Conductors.

E. Conductors shall not be looped to form dead-ends of either a temporary nature or a permanent nature.

F. Conductors shall not be wrapped around poles or other anchorages.

G. Conductors shall not be marred with temporary wire or hook hangers.

H. Only parallel jaw clamps shall be used in tensioning all conductors. The grooves of the clamps must be free from burrs, fins, or any roughness, and the ends of the grooves must be flared (bell-shaped).

I. Vertical kinks in the contact wire shall be removed.

J. Lateral kinks in the contact wire shall be removed if they affect the fit of any parts, or are judged as prejudicial to good current collection by Caltrain.

3.13 INSTALLATION OF OCS SUPPORTS ON BRIDGES

A. Existing reinforcement bars and pre/post tensioning tendons must be located by appropriate devices prior to drilling for anchor bolts.

B. Field drilling of bridge girder webs will not be permitted unless expressly permitted by the Bridge owner. A written copy of this permission will be provided to Caltrain prior to the commencement of any related work.

C. Attachments of OCS Supports to bridges shall only be at structure locations specified on the Contract Documents.

3.14 IDENTIFICATION OF OCS STRUCTURES

A. All OCS structures shall be clearly and permanently numbered, using the pole identification requirements shown on the Contract Drawings.

B. OCS supports under bridges, shall be assigned structural number in the same size and style as employed for poles.

3.15 INSTALLATION OF JUMPERS

A. Configurations of all types of jumpers shall be as shown on the Contract Drawings.

B. Jumper wires shall have ends projecting not more than 1/2 inch through open clamps.

C. In all cases, jumpers shall be installed so as to avoid conflicts with the pantographs, adjacent cantilevers, and hangers at all times.

D. Each jumper end shall be cleaned with an accepted decontaminant immediately prior to making connections.

E. Connectors shall be oriented as indicated and shall be installed in accordance with the manufacturer's recommendations.

F. Conductor interfaces of all clamps for feeder terminations, equalizing jumpers and continuity jumpers shall be coated with conductive grease before installation and cleaned of excessive grease after installation.

3.16 FIELD TOUCH-UP

A. Galvanized Metal Surfaces: Coat damaged surfaces to meet the finish of the original coating, with polystyrene organic rich compound containing not less than 91 percent by weight metallic zinc powder in dried form.

B. Painted Metal Surfaces: Clean, treat, and coat damaged surfaces with required rust inhibiting undercoating and finish coat paint system in accordance with paint manufacturer's instructions.

C. Fiberglass Reinforced Polyester Enclosures: Repair only minor damaged surface with materials and methods as recommended by manufacturer. Major damage will require complete component replacement.

3.17 FINAL ADJUSTMENT

A. After installation of cantilevers and final stringing of conductors, adjust support assembly components for setting of the final wire stagger, steady arm heel settings, contact wire height and cantilever inclination, so that the OCS alignment is within the specified design tolerances.

3.18 OCS CATENARY ACCEPTANCE MEASUREMENTS AND VISUAL INSPECTIONS

A. Perform acceptance measures, visual inspections, and related work in accordance with Section 34 30 86, OCS Testing.

3.19 OCS TESTING AND COMMISSIONING

A. Testing and commissioning of the overhead contact system shall be as specified in Section 34 30 86, OCS Testing.

END OF SECTION

SECTION 34 30 86

OCS TESTING

PART 1 - GENERAL

1.1 DECRIPTION

A. This Section includes specifications for the preparation of test plans, test procedures, supply of equipment, factory and field testing of the Overhead Contact System (OCS), preparation of test reports, and re-testing of items as necessary.

1.2 REFERENCE STANDARDS

A. Pertinent provisions of the applicable Standards listed in all OCS Specification Sections for this project shall apply to the work of this Section, except as they may be modified herein, and are hereby made part of this Section to the extent required.

1.3 QUALITY ASSURANCE

A. Perform the Work included in this Section in strict accordance with the requirements of Section 01400, Quality Control and Assurance.

1.4 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Submit a Test Program Plan for approval, prior to the submission of Test Procedures (see 1.5-B). The purpose of this plan is to:

1. Ensure that consideration to all of the testing requirements contained in this and other Sections of the Specifications have been addressed, along with consideration of relevant interfaces with other Contractors and Caltrain activities, including Rail Operations.

2. Made adequate provisions for testing in the overall Test Program Plan

3. To achieve an early mutual understanding on the range, depth and other aspects of OCS tests to be conducted. Provide the Test Program Plan with minimum requirements as indicated below:

    a. A flow diagram indicating the logical sequence of tests, starting with factory tests and continuing on to conclude with field demonstration tests.

    b. A list of test procedures (by test procedure number) to be submitted, preliminary submittal schedule, a preliminary schedule of tests, and a brief description of each factory and field test. The schedule portion of the program plan shall be a dynamic document to be updated as the program progresses.

    c. An outline and format of the procedure and test data sheets for each type of test.

    d. Requirements and recommendations for witnessing of all tests.

    e. A description of the in-plant and field test organization.

f. A detailed Safety Program defining all precautions to be taken, notices, signs and barriers to be posted concerning the safety of the public, work personnel and equipment. Define all precautionary measures to be taken prior to, during and following the test until such time as normal work is resumed.

C. Submit test procedures at least 45 days in advance of the scheduled tests. As a minimum, include the following test procedure:

1. Objective and scope

2. Test set-up and test equipment to be used

3. Personnel required for the test, including Caltrain personnel

4. Estimated duration of the test

5. Pass/fail criteria and samples of data sheets to be used.

D. Submit all tests must be performed in accordance with the approved test procedures. Any deviations will require Caltrain's approval prior to implementation.

E. Submit all test reports within 15 days after completion of tests. Test reports must contain all the data obtained during tests, an analysis of the data and conclusions relating from the test pass/fail criteria outlined in the test procedure. A test that fails must be repeated and corrective action taken. To pass the re-test must be outlined in a new test report.

F. Submit all types of tests to be covered in the Test Program Plan as applicable to the specific project. Include those required for testing and commissioning the Overhead Contact System following completion of construction, as specified in Part 3 of this Section. The following commissioning tests are required:

1. Acceptance Measurements

2. Visual Inspection of Completed OCS

3. Clearance Envelope Tests for Pantograph

4. Overhead Contact System Electrical Tests

5. Live Line Run Testing

G. A sample test plans and procedures are provided as an aid in developing the test plan. They are only to be used as a guide in preparing the contract-required detailed test plans and procedures, which must be specifically tailored for each of the tests to be performed on this project.

H. Submit calibration certificates for all testing equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Furnish details of the height and stagger gauges, and all other equipment necessary to record the Acceptance Measurements to Caltrain for information.

B. Furnish all electrical equipment and tools required to test and record the electrical tests. All test equipment must have been calibrated within the 6 months prior to the test and certificates of all equipment calibrations must be provided prior to the scheduling of any electrical tests.

PART 3 - EXECUTION

3.1 ACCEPTANCE MEASUREMENTS

A. Upon completion of each OCS segment of construction, measure the contact wire height, stagger, and other required dimensions and record the readings on the Acceptance Measurement Form.

B. Schedule acceptance measurements in advance. Perform measurements only in times of calm (less than 10 mph wind), dry weather, with either steady sunshine or continuous cloud cover.

C. Prepare a "project-specific" Acceptance Measurement Table that includes the following information:

1. Track designation.
2. Wire Run Number as indicated on the OCS Layout Plans.
3. Drawing number(s) where the structures of the Wire Run are shown.
4. Name(s) of person(s) performing the acceptance measurements.
5. Sheet number of a Wire Run set.
6. OCS equipment type or style being measured.
7. Temperature of the conductors (messenger and/or contact) in degrees F during the time of measurement.
8. Weather condition during time of measurement (e.g., windy, raining).
9. The date the measurements are made.
10. Station location of the structure in feet (stationing reference) as indicated.
11. Horizontal distance of the pole to the closest served adjacent track centerline(s) measured from the inside running edge of the nearest rail to the face of the pole (plus 2'-4 1/4").
12. Cross-level difference of the two rails measured to the structure station (the actual track super-elevation at the structure).
13. Lateral distance measured at the structure from the contact wire to the vertical or super-elevated centerline of the track (referred to as stagger).
14. The vertical distance between the contact wire at the structure measured from the mean rail level (referred to as contact wire height at the support).
15. The same as (13) except measured at mid-span (referred to as actual track super-elevation at mid-span).
16. Distance between the contact wire and the vertical or super-elevated centerline of the track measured at mid-span (referred to as mid-span offset).

17. The same as (15) except measured at mid-span (referred to as contact wire height at mid-span).

18. The average of the contact wire heights at the structures (at each end of the span) minus the contact wire height at mid-span.

19. The rate of change of contact wire between the structures. This is equal to the difference of contact wire heights at each structure divided by the span (referred to as gradient).

20. Vertical distance (system height) measured at the structure between the contact wire and the messenger wire.

21. Rise or fall of balance weight from median position (at design temperature).

22. The vertical distance between the underside of the bridge and the vertical or super-elevated centerline of the track measured at low point of bridge, each bridge face and center.

23. Electrical clearance from the messenger or contact wire support to underside of bridge, with uplift force of 25 lbs. on the contact wire at the point of measurement, measured at each bridge face and at the mid point of bridge.

24. Electrical clearance from the ATF to the underside of bridge, measured at each bridge face and at the mid-point of the bridge.

25. At overlaps and turnouts - height of in-running and out-of-running contact wire above rail – referenced above mean rail level at each structure.

26. Comments or remarks as required.

D. Acceptance Measurements form will be used to determine compliance with the OCS design. The form will identify necessary corrections to be performed.

E. Make corrections , except for adjustments required by Caltrain which are changes beyond the requirements specified in the Contract Documents and shop drawings.

F. After execution of corrections, re-measure and record affected data and submit the results to Caltrain.

G. The work of this Section shall not be complete until all corrections are performed and accepted.

H. Submit completed Acceptance Measurements Tables in accordance with the Contract Documents.

3.2 VISUAL INSPECTION OF COMPLETED OVERHEAD CONTACT SYSTEM

A. At Contact Wire Level (in hi-rail bucket truck or platform truck), make the following visual checks, and promptly remedy all unsatisfactory conditions detected:

1. Check fit and tightness (torque) of all components and fasteners

2. Check security of split pins for 90 degree minimum bend and locknuts are secure

3. Check contact wire for kinks, rolls, and damage

4. Check messenger wire for damage to strands

5. Check ATF for damage to strands

6. Check OPGW/static wire for damage to strands

7. Check for correct steady arm fittings

8. Check heel settings of steady arms

9. Check that jumpers are of correct type, have adequate travel capability, are properly fitted, are pointed in the correct direction, and are well formed so as to prevent a hard spot and avoid fatigue failure.

10. Check posture of auto tensioning devices and a termination yoke plate

    a. Check FTA and MPA

11. Check that cantilever hinge fittings have freedom to move under load

12. Check that a wire passing through a cantilever and not attached to it will clear any part of this cantilever by at least 3" throughout the auto-tensioned (AT) operational range of +20° F to +145° F.

13. Check for electrical air clearance and insulation between adjacent or crossing OCS wires

14. Check all OCS installations for locations of possible interference with passage of pantographs, including spots where pantographs could tangle with wires or suspension assemblies.

B. From ground level, make the following checks:

1. Check that auto tensioning devices are positioned correctly (vertically), have freedom to travel and that balance weights do not bind, rub on the inside surface of the OCS pole. Note: this check may require the use of aerial lift equipment.

2. Check that cantilevers and pull-off assemblies have correct along-track offset.

3. Check that headspan and cross-span assemblies have correct along-track offset.

4. Check that hangers are complete, uniform and plumb, and installed within design position.

5. Check out safety requirements in accordance with NESC and other applicable safety codes.

3.3 CLEARANCE ENVELOPE TESTS FOR PANTOGRAPH

A. The purpose of these tests is to verify the mechanical and electrical clearances of the electric locomotive's pantograph on each section of the system. The tests shall be conducted after all installations are complete and after the Acceptance Measurements have been made, submitted and approved. Any section found to have insufficient clearance shall be adjusted to provide the required clearance.

B. Pantograph Clearance Envelope: Provide rail mounted height stagger gauge for the initial tests, having the same dynamic profile as the EMU's pantograph. This gauge shall be used to verify the mechanical clearances between the pantograph and OCS components such as the heels of steady

arms and contact wire clamps, and the electrical clearances between the OCS/pantograph combination and civil structures, such as at overhead bridges, tunnels and station platforms.

3.4 OVERHEAD CONTACT SYSTEM ELECTRICAL TESTS

A. General Test Requirements:

1. All OCS conductors, feeder cables, disconnect switches, section insulators and phase breaks must be confirmed, via field testing after installation, that they meet all electrical performance requirements of the Contract Documents.

B. Loop Continuity Test

1. Loop continuity tests shall be performed to ensure continuity and resistance is as expected. The loop shall include the Messenger and Contact Wire and the Neutral Return system including running rails, impedance bonds and static wires.

2. At one end of the test section, install test lead from OCS near an open disconnect switch to the running rail. Connect 24 v battery to the other end of the test section. Record voltage and current. Test section shall not exceed one mile unless otherwise approved by Caltrain.

3. Calculate the expected loop resistance including messenger, contact wire, impedance bonds, static wire if connected to impedance bonds in the test section, and the quantity of running rails in the test section. Refer to the Neutral Return Schematics to determine quantity of parallel running rails and static wire connections in the test section.

4. If the loop resistance is over five percent greater than the expected resistance as calculated, then the loop shall be investigated, and repairs conducted. Retest to verify resistance is as expected by calculation.

C. Voltage Withstand Testing

1. A Voltage Withstand test, also referred to as a High Potential (Hi-Pot) Test, shall be performed on all OCS energized conductors and equipment using the test voltages denoted below. The Voltage Withstand tests serve the following purposes:

   a. Components such as insulators and ATF cables are checked for leakage.

   b. The electrical withstand of minimum clearance areas, such as at overhead bridges and tunnels, are verified under static conditions.

   c. The electrical withstand of section insulators, phase breaks and disconnect switches are verified.

   d. The test provides an OCS performance basis for newly constructed OCS and a reference for periodically checking for any reduction in the insulation level of the OCS sections, by comparing voltage and leakage current with the previously measured values.

2. A nominal DC Hi-pot voltage of 51 kV (2 times nominal plus 1 kV) shall be used for the test. Hi-pot shall be carried out on the OCS sections as soon as possible after the continuity tests have been completed, in order or sections lengths or to ensure that all the sections being tested is electrically continuous and is subjected to the test voltage.

Leakage currents values in milli-amperes shall be recorded and re-computed for sections lengths of 1-2 miles for further evaluation by Caltrain.

3. Procedure for OCS Along Track: Along-track feeders which are electrically common to the OCS should be connected to the OCS but disconnected from the substation. Feeder cables shall be disconnected from the section under test. Adjacent OCS sections which are electrically isolated from the section under test shall be grounded by connecting the OCS to the rails. The full test voltage must be sustained for duration of 10 minutes, after incrementally ramping up the test voltage in 5 kV increments up to the nominal test voltage. The test voltage shall be held for 30 seconds at each increment. The leakage current at each value shall be measured and recorded, together with weather conditions and temperature.

4. The leakage current at the final test voltage shall be measured and recorded together with the weather conditions and temperature.

5. Just prior to the voltage Withstand test (Hi-pot), the conductors and equipment involved shall undergo an insulation resistance and continuity test (Loop Resistance) utilizing a megger tester at 1 kV for a duration of one minute.

6. OCS conductors and ATF shall be tested separately.

7. OCS conductors for each individual track shall be tested separately.

8. All surge arresters and transformers shall be disconnected from the OCS and feeders prior to the testing.

9. OCS and ATF will be tested in discrete sections, typically from one point of feed (i.e., a substation, switching station or parallel feeding station) to the most adjacent point of feed.

10. Precautions: The Hi-pot measurements require application of high voltage to the OCS. Proper regard must be paid to safety. Test zones shall be clearly identified. All safety requirements established in the Safety program concerning the public, work personnel and equipment shall be strictly enforced. Personnel not directly associated with the test should be clear of the tracks. Sections of OCS and associated feeders under test shall be isolated from the adjacent sections of the system, and all OCS sections adjacent to the section under test shall be grounded.

3.5 INTEGRATED TESTS

A. Following the successful testing of the Overhead Contact System as specified in this Section, assist Caltrain in performing integrated tests with other Systems (i.e., signals, traction power, vehicles, etc.).

B. Sectionalization Testing:

1. General: The sectionalization tests shall be performed on the Overhead Contact System to demonstrate the test sectionalization scheme and operation/functionality of disconnect and/or bypass switches and section breaks.

2. Prior to commencement ensure that all pre-cursor inspections and tests have been completed and associated test reports reviewed and approved.

3. The pre-requisites for energization, as specified in this Specification Section are completed.

4. All parties working in the vicinity of the OCS are notified prior to the test.

5. Energize at 25kV all or part of the OCS that has been approved to be tested.

6. Starting from pre-agreed starting point and working toward the pre-agreed finishing point the Contractor shall operate all AC feeders, disconnect and bypass switches within the pre-determined test area to:

   a. Demonstrate the TES sectionalization scheme for each line section, at each substation and at each special track-work location.

   b. Demonstrate the operation/functionality of disconnect and/or bypass switches.

7. Verify SCADA indications received at CCF correctly indicate the status of the sectionalization.

C. Dead Run Tests

1. Pantograph tests on the OCS (known as "Dead Car Pull Tests") will be performed during integrated testing using an electric locomotive (supplied by Caltrain) with the pantograph in normal contact with the de-energized contact wire. These tests are performed to assure a smooth, shock-free passage of the pantograph, especially at turnouts, section insulators, phase breaks, overlaps and locations where the wire height changes. Particular attention will be focused on wire takeover at overlaps, turnouts and crossovers, and to confirm the lack of hard spots at all locations. The Contractor shall be responsible for all adjustments required as a result of these tests. Any adjustments required shall be performed at the expense of the Contractor.

D. Live Run Tests

1. Once the "Dead Car Pull Tests" are completed, and any required corrections are made, Caltrain will operate an electric locomotive on the energized Overhead Contact System starting at 5 mph and increasing at 5 mph increments until maximum speed in the track segment is achieved in both directions to verify the OCS performs as required and to confirm that there is no arcing at any locations on the OCS that is deemed by Caltrain to be prejudicial to good current collection and injurious to the expected service life of the contact wire. Any repairs deemed necessary will be made immediately. After the successful completion of the "Dead Car Pull Test" and any resulting punch list items, video-tape the OCS in its entirety (by means of a video camera mounted on the roof of an electric locomotive during a live train test run) and furnish two (2) copies of the video.

E. Contractor shall provide Systems Integrated Test Procedures for integrated testing.

F. Operate and maintain the Overhead Contact System until the final acceptance for revenue service.

END OF SECTION

SECTION 34 30 89

OCS SPECIAL TOOLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for furnishing special tools required for the OCS work, such as: stringing blocks, live line tools, test equipment, hoists, cable reel stands, etc.

B. All special tools specified herein shall be purchased as new for this project, and then may be used by the Contractor and shall remain the Contractor's property throughout the construction period of the Overhead Contact System, and during its subsequent testing as specified in Section 34 30 86, OCS Testing. Following acceptance and turnover of the completed system, all special tools are to be turned over in good working condition to Caltrain. Deliver to a location as directed.

1.2 QUALITY ASSURANCE

A. Perform the Work included in this Section in strict accordance with the requirements of Section 01400, Quality Control and Assurance.

1.3 SUBMITTALS

A. Submit shop drawings and catalog cuts for review, showing details and dimensions of all special tools, together with complete specifications of materials proposed for the tools.

B. Submit operating Instructions and Procedures

C. Refer to Special Provisions Section 01300, Submittals and Deliverables, for submittal requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials proposed are to meet the applicable performance requirements. Materials are to be corrosion resistant and durable.

2.2 MANUFACTURED ITEMS

A. Furnish project specific manufactured items or equal from the following list, following OCS acceptance:

No.	Item	Manufacturer & Catalog No.	Quantity
1.	Grounding Cable	A. B. Chance, Catalog No. 56119; Size: 4/0; Color: Yellow	
2.	Copper Ferrules	A. B. Chance, Catalog No. 0600-2617; Size: 4/0	
3.	Hydraulic Compression Tool	Burndy, Hypress Y-46	
4.	Height Stick, Measuring with Carrying Case	Hastings Fiber Glass Products, Inc., Model NO. 806-5, C8104	
5.	Electric/Hydraulic Pump, 10,000 psi	Burndy Products, Burndy Model No. EPP10-1HP	
6.	Ratchet Chain Hoists:	Coffing, 1.5 Ton Capacity, Model No. ATGI 3.0 Ton Capacity, Model No. FTGI 4.5 Ton Capacity, Model No. Zg-41/2	
7.	Ratchet Action Cable Cutters	H.K. Porter, Hard Cable Cutters; Hall's Safety Equipment, Catalog No. 8690FH	
8.	Stainless Steel Cutters	McMaster-Carr Supply Corp., Part No. 39615A72	
9.	Grips (Line Pulling)	Klein - Chicago Grip Suitable for 70 mm sq BZII stranded wire. Grip Suitable for 107 mm sq Copper trolley wire. Guy Wire Grip – Cat. No. 1628-17 3/8" Wire Rope - Cat. No. KT4500	
10.	Grip (Line Pulling)	ABB SUSA, Inc. or equivalent Wedge Type Come-Along, Type III Suitable for 70 mm sq BZII stranded wire.	
10A.	Grip (Line Pulling)	ABB SUSA, Inc. or equivalent Wedge Type Come-Along, Type III Suitable for 107 mm sq Copper trolley wire.	
11.	Utility Slings, 3-Ton Capacity	A. B. Chance or Rhino	
12.	Grounding Safety Tool, Snap-On Grounding Clamp w/Applicator	A. B. Chance, Catalog No. HG-3706-1	
13.	Telescoping Disconnect Tool, Epoxy Glass w/Carrying Case	A. B. Chance, Catalog No. C403-1601	

No.	Item	Manufacturer & Catalog No.	Quantity
14.	Snap-On Grounding Clamp	A. B. Chance, Catalog No. G3622-1	
15.	Flat-Face Grounding Clamp	A. B. Chance C6000437 C6000438	
16.	Dies	Burndy or equivalent, Die Suitable for 70 mm sq BZII stranded wire. Die Suitable for 107 mm sq Copper trolley wire. Die Suitable for 190.8 ACSR Static Wire Die Suitable for 300 kcmil ACSR Feeder Cable UDie Adapters – PUADP 4/0Cable – U249 Die suitable for flexible jumpers	
19.	Laser Height/Stagger Gauge	Abtus Limited, ABT 4640	
20.	Non-Malleable Mallet		
21.	Rail Mounted Stagger Gauge		

B. The above tools are the minimum requirements to be furnished. The quantity of tools to be provided shall be as required in the Project Specific General Provisions and shall be in accordance with the project magnitude.

C. Provide three (3) sets of any special tools not listed that are required for the installation and maintenance of any specialized OCS components.

D. This requirement shall not restrict the use of other tools and equipment used in the construction of the OCS.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Procurement of the Special Tools shall not occur until the required submittals have been reviewed and approved.

B. Deliver the assembled products complete and ready for use in sufficient time for OCS maintenance purposes.

C. Protect all products from damage during the duration of the project and deliver all items as directed in good working condition at the acceptance and completion of the project. All special tools and equipment required by this specification that are damaged and rendered useless for the intended purpose or are lost or stolen during the execution of this contract, shall be replaced.

END OF SECTION

SECTION 34 30 93

OCS MANUALS AND TRAINING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes requirements for Overhead Contact System (OCS) technical manuals and training programs.

B. Technical manuals shall comprehensively address all phases of OCS system configuration, operation, maintenance, repair and spare part provisioning.

C. Training and support materials shall be provided to enable Caltrain personnel to operate and maintain the complete OCS. The training program shall include detailed instructions, demonstrations and supervised hands-on training.

D. Training support materials shall be provided to Caltrain to enable Caltrain to educate emergency response teams and the public, including schoolchildren, with regard to the OCS.

1.2 RELATED SECTIONS

None

1.3 SUBMITTALS

A. Refer to Special Provisions Section 01300, Submittals and Deliverables for review process.

B. Submit three (3) hard-copy sets and one (1) electronic copy of the Operation and Maintenance (O&M) manuals to Caltrain for review and approval that, as a minimum, addresses project specific items from the following list:

1. OCS Conductors and Feeders
2. Section Insulators
3. Balance Weight Anchor Assemblies
4. Mid-Point Anchors and Fixed Termination Assemblies
5. Pole Mounted Disconnect Switches and Manual/Motor Operators
6. OCS Poles
7. Surge Arresters
8. Cantilever Assemblies (All types utilized) and Registration Components
9. Pull-Off and Backbone Assemblies
10. Headspan and Cross-span Assemblies
11. Stagger/Height Gauges

12. Maintenance and Inspection Equipment

13. Down Guy Assemblies

14. Bridge Attachment Assemblies

15. Hanger Assemblies

16. In-Span Insulators

17. Practices for Installing and Testing Cables

18. Splicing

C. In addition, submit five (5) electronic copies of the O&M Manuals on electronic media in "Word" 2013 format and Adobe X1 pdf (or most current editions).

D. Training Program Materials: Submit one complete reproducible set of printed training program materials, three (3) hard-copy sets, and one (1) electronic copy to Caltrain. In addition, submit five (5) electronic copies on CD's in "Word" 2013 format and Adobe X1 pdf format (or most current editions) of the Training Program Materials.

E. Submit a training plan to Caltrain for approval.

1.4 QUALITY CONTROL

A. Perform the Work included in this Section in strict accordance with the requirements of Section 01400, Quality Control and Assurance.

B. Provide qualified instructors who are thoroughly familiar with all subject material for each training session. Caltrain shall have final proposed approval regarding instructor qualifications.

PART 2 - PRODUCTS

2.1 OPERATIONS AND MAINTENANCE MANUALS

A. General:

1. Manuals shall consist of 8½" x 11" sheets bound in loose-leaf type binders. The binder holes shall be reinforced unless a multiple-hole configuration with more than seven (7) holes is used.

   a. Foldout diagrams or illustrations may be employed with a maximum size of 11" x 17". The title shall be visible when the sheet is folded.

   b. Covers shall be oil, grease, solvent, and wear resistant.

   c. The paper and ink shall resist smearing, fading and deterioration from age.

2. Manuals shall be written in English to be understood by a high school graduate with two (2) years of experience in a related field but with minimal knowledge of railroad or transit operations. The O&M Manual is not a Linesman's training course. The Maintainer will require having experienced Traction Linesmen within their staff. The writing shall be concise and free of ambiguities.

3. Manufacturer's standard manuals will be acceptable, subject to approval from Caltrain, if they deviate only slightly from the requirements specified herein.

4. Revisions to a manual shall be reflected in a revision index which is a part of each manual and is revised with each manual update.

5. Submittals for O&M Manuals shall conform to the following sequence: Contractor shall submit a complete listing of the tables of contents of the complete O&M Caltrain's approval for 50 percent of the Project completion status. The Contractor shall submit 5 copies of a complete first draft of the O&M manual prior to 80 percent of project completion status. The Contractor shall submit the final three (3) copies of the O&M manual prior to start of integrated testing.

B. Maintenance and Repair Manuals: Prepare maintenance and repair manuals as specified herein. Additional instructional material shall be provided in electronic format. Include in each manual:

1. General descriptions

2. Theory of operation

3. Sectioning diagrams

4. Feeder routing diagrams

5. Preventive maintenance tasks and procedures, including recommended intervals

6. Troubleshooting and repair procedures

7. Dismantling and reassembly procedures

8. Spare part requirements

9. Maintenance equipment lists

10. Safety Procedures

11. Any other information necessary to ensure proper maintenance and repair

C. Operation Manuals: Prepare operation manuals as specified herein. Include the following in each manual, as applicable:

1. Theory of Operation

2. Detailed operating instructions

3. Test procedures

4. Safety precautions

5. Functional relationship with other equipment or systems

6. Operational limits and restrictions

7. Other information necessary for proper and efficient operation

D. Installation Manuals: Prepare installation manuals as specified herein. Include in each manual, as applicable, the following:

1. A description of equipment, including drawings and detailed narrative of function

2. Standard installation procedures

3. Safety procedures

4. List of special tools required to perform installation

5. Any other information necessary to ensure proper installation

2.2 TRAINING PROGRAM

A. Training Plan: Develop a training plan that documents the Contractor's approach for providing training to Caltrain's operations, maintenance and engineering personnel, technicians, supervisors and management personnel, plus a separate plan for public and emergency response team education. The plan shall include but not be limited to:

1. Performance objectives that state the expected behavior, the conditions under which performance will occur, and the measures and standards to be applied.

2. Lesson plans that include the sequence of activities, an outline of the content, learning strategies to be used (e.g., classroom presentation, hands-on practice, audio/video presentation, etc.).

3. Methods and criteria for evaluating performance, including an objective grading system to report progress of trainees. Grading shall be kept confidential and furnished only to personnel designated by Caltrain.

4. Resources required, such as equipment, classroom or public hall and shop space.

5. A schedule for delivery of training courses to all designated Caltrain personnel. The size of classes, time and location for the training must receive approval in advance by Caltrain. Include scheduled time allocated to training Caltrain trainers.

B. Training Materials: Provide materials to support the training courses, including: instruction guide, training aids, student workbooks and operation and maintenance manuals. Drafts of materials shall be presented to Caltrain for review at periodic intervals: In design stage, first draft stage, and final version. Throughout the Contract, as changes to the OCS are made, the Contractor shall update and revise training materials accordingly.

1. Instructor Guide: Provide Instructor Guides containing: course outline, agendas, objectives, lesson plans, training aids, presentation guidelines, suggested discussion questions, and criteria for measuring student performance.

2. Training Aids: Provide training aids, such as mock-ups, scale models, overhead transparencies, electronic formats. All training aids shall be of durable construction and shall become the property of Caltrain. Verify that any equipment or tools used during training are in good working condition both before and after training sessions.

3. Student Workbooks: Provide student workbooks that include course objectives, a course agenda, schedule of sessions, copies of overhead transparencies, lecture outlines, and any additional printed material used during the course.

C. Class Lectures/Presentations: Provide experienced trainers who are knowledgeable about the subject matter. They must be able to answer questions and give detailed explanations and demonstrations. All presentations shall be made in English. To help Caltrain trainers become familiar with the content and delivery of the training, the Contractor shall record their classroom presentations or provide staged recorded versions, electronic formats. The Contractor shall furnish the recording device and provide personnel to operate it.

2.3 TRAINING COURSES

A. General and operational training shall be provided in the following areas:

1. Overhead Contact System operation

2. Safety procedures

3. Test equipment operation.

B. Maintenance and repair training shall be provided in the following areas:

1. Overhead Contact System equipment

C. The Contractor shall designate the total number of hours allocated for training of each Caltrain work group listed below; the minimum shall not be less than:

1. Twenty (20) hours for management personnel/supervisors/for a class size of up to ten (10) people.

2. Eighty (80) hours for maintenance and engineering personnel and technicians for a class size of up to twenty (20) people.

3. Eight (8) hours for operations personnel for a class size of up to ten (10) people.

D. The Contractor shall also designate a minimum of eighty (80) hours for the training presentations to emergency response teams, the public and all schools located in the townships along the rail corridor.

PART 3 - EXECUTION

Not used.

END OF SECTION

SECTION 34 30 96

OCS SPARE PARTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes specifications for the supply of Mandatory Spare Parts for the Overhead Contact System.

B. In addition, requirements are outlined in this Section for the supply of Recommended Additional Spare Parts.

1.2 RELATED SECTIONS

N/A

1.3 SUBMITTALS

A. Unless otherwise specified, all submittals shall be in accordance with Special Provisions Section 01300, Submittals and Deliverables.

B. Submit a detailed Mandatory Spare Parts listing to Caltrain for review and approval after all OCS material submittals required by other Specifications Sections for this project have been submitted.

C. Within thirty (30) days after receipt of acceptance for the Mandatory Spare Parts list, submit a Recommended Spare Parts List for review and acceptance.

1.4 QUALITY CONTROL

A. Perform the Work included in this Section in strict accordance with Section 01400, Quality Control and Assurance.

PART 2 - PRODUCTS

2.1 PROVISIONS

A. General:

1. All spare part items shall be identical to the approved installed items, and shall meet all requirements of the appropriate sections of these Specifications. Parts shall be made available from a supplier for a minimum period of seven (7) years after the end of this Contract.

2. All items shall be complete and ready for installation, except for wire or cable necessary for connections.

3. The quantity of spare parts to be provided shall be as required in the Project Specific General Provisions and shall be determined based on the project magnitude.

B. Overhead Contact System Provisioning: Provide project specific items from the following listed Mandatory Spare Parts:

Item No.	Description of Spare Part	Quantity	Unit
1.	Catenary Poles, 2 of Each Type (Length equal to tallest pole)		Each Type
1.A	Portal Beams - 4-Track		Each
1.B	Long Reach Cantilever – 2-Track		Each
2.	Cantilever Assemblies (for Simple Catenary, unless noted otherwise): a. Push-Off – Light Load b. Push-Off – Medium Load c. Push-Off – Heavy Load d. Pull-Off – Light Load e. Pull-Off – Medium Load f. Pull-Off – Heavy Load g. Out of Riding Cantilever h. Two Track Cantilever i. Single Contact Wire Push-Off j. Single Contact Wire Pull-Off		 Each Each Each Each Each Each Each Each Each Each
3.	Cantilever Components: a. Registration (Steady) Arms - Light Load b. Registration (Steady) Arms - Medium Load c. Registration Arms - Heavy Load		 Each Each Each
4.	Headspan Assemblies (Simple Catenary) 4-Track Open Route		Each
5.	Cross-Span Assemblies (Single Wire) 3-Track Open Route		Each
6.	25 kV AC Pole-Mounted Disconnect Switches Non-Load Break, Motor-Operated (Current rating to match highest rated sectionalizing switch.)		Each
7.	Section Insulators, Bridging - Simple Catenary		Each
10.	Balanced Weight Assemblies		Each
11.	Surge Arrester Assemblies		Each
12.	Hanger Assemblies		Each
Item No.	Description of Spare Part	Quantity	Unit

13.	In-Span Messenger Insulator & Fittings		Each
14.	In-Span Contact Wire Insulator & Fittings		Each
15.	Termination Turnbuckles		Each
16.	Pole Bands (to fit largest diameter pole) and Pole Clamps for Wide Flange Poles		Each
17.	Contact Bridge (Wire Cross) Assembly		Each
18.	Messenger Wire		LF
19.	Contact Wire		LF
20.	ACSR Feeder Cable		LF
21.	Insulated Feeder Cable		LF
22.	Static Wire		LF
23.	Termination Lugs (NEMA 2-Hole) for Feeder Cable		Each
24.	Superflex Jumper		LF
25.	Stainless Steel (Non-Rotating) Cable for BWA's		LF
26.	3/8" Stainless Steel Wire Rope		LF
27.	¼" Stainless Steel Wire Rope		LF

C. For Item Nos. 2, 4, and 5 the assemblies indicated are in component form and not pre-fabricated units.

D. For Item Nos. 18 thru 22, wire must be furnished on metal cable reels with a maximum reel diameter of sixty (60) inches and a maximum reel width of forty-eight (48) inches.

E. Special Tools and Equipment: Provide special tools and equipment as needed for installation, adjustment and testing associated with the OCS installation in accordance with Section 34 30 89, OCS Special Tools.

2.2 RECOMMENDED ADDITIONAL SPARE PARTS LIST

A. Develop and submit a list of recommended additional spare parts for the Overhead Contact System for review and approval to Caltrain.

B. The quantities in the list shall be for two (2) years of revenue service. The list shall include fair market value prices for the parts, including applicable sales tax. Selected parts from the list shall be deliver within sixty (60) days after the order. Prices shall be certified as its current prices for the spare parts and may be offered to others for the same quantity purchase.

C. The Spare Parts List shall include the following information for each part:

1. Supplier's stock number
2. Supplier and manufacturer's part number
3. Name, address and phone number of supplier or manufacturer
4. Nomenclature (description)
5. Assignment (where part is to be used)
6. Drawing reference number
7. Lead time for reorder
8. Frequency and reasons for replacement based on records
9. Each part or component shall be identified as being part of next larger assembly or sub-assembly.

PART 3 - EXECUTION

3.1 DELIVERY

A. Deliver all Mandatory and Recommended Additional Spare Parts suitably packed/boxed in a new, undamaged condition to a location in the San Francisco Metropolitan area as directed. Pack all material for warehouse storage and clearly mark with manufacturer's part and/or style number. Damaged materials and parts shall be replaced.

B. Complete delivery and storage for all parts no earlier than 30 days prior to, or no later than, the completion of OCS testing.

3.2 WARRANTY USE

A. In the event that spare part items must be used in the course of satisfying warranty procedures, the items shall be promptly replaced.

END OF SECTION