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SECTION 03 21 00
REINFORCING STEEL

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Reinforcing steel bar requirements for concrete construction.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 03 31 00 – Structural Concrete

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. SP 66, ACI Detailing Manual.
   2. 318, Building Code Requirements for Structural Concrete.

B. ASTM International (ASTM):
   3. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

C. American Welding Society (AWS):
   1. D1.4, Structural Welding Code - Reinforcing Steel.

D. Concrete Reinforcing Steel Institute (CRSI):

E. Current California Department of Transportation Standard Specifications 2010.
American Railway Engineering and Maintenance-of-Way Association (AREMA)

1. Chapter 8 – Concrete Structures and Foundations.

1.03 SUBMITTALS

A. Shop Drawings:

1. See Division 01 for requirements for the mechanics and administration of the submittal process.

2. Product technical data including:

   a. Acknowledgement that products submitted meet requirements of standards referenced.

   b. Manufacturer's installation instructions.

   c. Mill certificates for all reinforcing.

   d. Manufacturer and type of proprietary rebar mechanical splices.

   e. Manufacturer and type of rebar adhesive anchor including installation instructions.

3. Qualifications of welding operators, welding processes and procedures.

4. Rebar number, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, concrete cover and rebar supports.

5. Sufficient rebar details to permit installation of reinforcing.

6. Rebar details in accordance with ACI SP 66.

7. Locations where proprietary rebar mechanical splices are required or proposed for use.

8. Shop Drawings shall be in sufficient detail to permit installation of reinforcing without reference to Contract Plans.

   a. Shop Drawings shall not be prepared by reproducing the plans and details indicated on the Contract Plans but shall consist of completely redrawn plans and details as necessary to indicate complete fabrication and installation of all reinforcing steel.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Welding operators, processes and procedures shall be qualified in accordance with AWS D1.4.
2. Welding operators must have been qualified during the previous 12 months prior to commencement of welding.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Support and store all reinforcing above ground.

B. Ship to jobsite with attached plastic or metal tags with permanent mark numbers which match the Shop Drawing mark numbers.

C. Handling of Epoxy-Coated Rebar:

1. Use padded or nonmetallic slings and padded straps to protect coated reinforcement from damage.

2. Handle bundled bars to prevent sagging that could damage the coating.

3. Do not drop or drag rebars.

4. Store on wooden cribbing.

5. Coated rebars subject to rejection by Engineer if rebar coating has been damaged. The rebars may be used for repair if approved by Engineer.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURES

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Rebar adhesive anchors:
   a. HIT-HY150 System by HILTI FASTENING SYSTEMS, INC.
   b. Epcon Adhesive Anchoring System by ITW Ramset/Red Head.
   c. Power-Fast by Powers Fastening, Inc.

2. Rebar mechanical splices:
   a. Lenton Rebar Splicing by Erico, Inc.
   b. Richmond dowel bar splicer system by Richmond Screw and Anchor Co., Inc.
   c. Bar-Grip Systems by Barsplice Products, Inc.

B. Submit request for substitution in accordance with Division 01.
2.02 MATERIALS

A. Reinforcing Bars: ASTM A615, grade 60, deformed.
B. Reinforcing Bars to be Welded: ASTM A706.
C. Welded Wire Reinforcement: ASTM A185 or ASTM A497.
D. Smooth Dowel Bars: ASTM A615, grade 60 with metal end cap to allow longitudinal movement equal to joint width plus 1 inch.
E. Epoxy-Coated Rebars: ASTM A775 and ASTM A615, Grade 60, meeting Annex A1 for epoxy coating.
F. Epoxy-Coated Rebar Patching Material:
   1. Compatible with the coating material.
   2. Inert in concrete.
   4. Obtained from the manufacturer of the epoxy resin that was used to originally coat the rebars.
G. Proprietary Rebar Mechanical Splices: To develop in tension and compression a minimum of 125 percent of the yield strength of the rebars being spliced.
H. Welding Electrodes:
   1. E90 meeting requirements of AWS D1.4.
I. Rebar Adhesive Anchors:
   1. Manufactured for the specific purpose of embedding and developing 125 percent of the yield strength of rebars in hardened concrete.

2.03 ACCESSORIES

A. Metal Chairs, Runners, Bolsters, Spacers, Hangers, and Other Rebar Supports:
   1. Plastic-coated tips in contact with forms.
B. Protective plastic caps at mechanical splices.

2.04 FABRICATION

A. Tolerances:
1. Sheared lengths: +1 inch.

2. Overall dimensions of stirrups, ties and spirals: +1/2 inches.

3. All other bends: +0 inch, -1/2 inches.

B. Minimum diameter of bends measured on the inside of the rebar to be as indicated in ACI 318 Paragraph 7.2.

C. Ship rebars to jobsite with attached plastic or metal tags.
   1. Place on each tag the mark number of the rebar corresponding to the mark number indicated on the Shop Drawing.
   2. Mark numbers on tags to be so placed that the numbers cannot be removed.
   3. For epoxy-coated rebars, use only plastic tags secured to rebars by nylon or plastic ties.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Tolerances:

1. Rebar placement:
   a. Clear distance to formed surfaces: +1/4 inches.
   b. Minimum spacing between bars: -1/4 inches.
   c. Top bars in slabs and beams:
      1) Members 8 inches deep or less: +1/4 inches.
      2) Members between 8 inches and 2 feet deep: -1/4 inches, +1/2 inches.
      3) Members more than 2 feet deep: -1/4 inches, +1 inches.
   d. Crosswise of members: Spaced evenly within +1 inches.
   e. Lengthwise of members: +2 inches.

2. Minimum clear distances between rebars:
   a. Beams, walls and slabs: Distance equal to rebar diameter or 1 inch, whichever is greater.
   b. Columns: Distance equal to 1-1/2 times the rebar diameter or
1-1/2 inches, whichever is greater.

   c. Beam and slab rebars shall be threaded through the column vertical rebars without displacing the column vertical rebars and still maintaining the clear distances required for the beam and slab rebars.

B. Minimum concrete protective covering for reinforcement: As shown on Plans.

C. Minimum concrete protective covering for reinforcement, unless indicated otherwise on Plans:

   1. Three (3) inches for concrete cast against earth, 2 inches all other locations.

D. Unless indicated otherwise on Plans, provide splice lengths for reinforcing as follows:

   1. For rebars: Class B splice meeting the requirements of Paragraph 12.15 of ACI 318.

   2. For welded wire reinforcement:

      a. Splice lap length measured between outermost cross wires of each fabric sheet shall not be less than one (1) spacing of cross wires plus 2 inches, nor less than 1.5 x development length nor less than 6 inches.

      b. Development length shall be as required for the yield strength of the welded wire reinforcement in accordance with Paragraph 12.8 of ACI 318.

   3. Provide splices of reinforcing not specifically indicated or specified subject to approval of Engineer.

      a. Mechanical proprietary splice connectors may only be used when approved or indicated on the Contract Plans.

E. Reinforcing Steel Splices:

   1. Splices of reinforcing bars shall consist of lap splices, service splices, or ultimate butt splices.

   2. Splicing of reinforcing bars will not be permitted at a location designated on the plans as a "No-Splice Zone."

   3. At the option of the Contractor, reinforcing bars may be continuous at locations where splices are shown on the plans.

   4. The location of splices, except where shown on the plans, shall be determined by the Contractor using available commercial lengths where practicable.
5. Unless otherwise shown on the plans, splices in adjacent reinforcing bars at any particular section shall be staggered.
   
a. The minimum distance between staggered lap splices or mechanical lap splices shall be the same as the length required for a lap splice in the largest bar.
   
b. The minimum distance between staggered butt splices shall be 2 feet, measured between the midpoints of the splices along a line which is centered between the axes of the adjacent bars.

6. Lap Splicing Requirements:
   
a. Splices made by lapping shall consist of placing reinforcing bars in contact and wiring them together, maintaining the alignment of the bars and the minimum clearances.
   
b. Should the Contractor elect to use a butt welded or mechanical splice at a location not designated on the plans as requiring a service or ultimate butt splice, this splice shall conform to the testing requirements for service splice.
   
c. Reinforcing bars shall not be spliced by lapping at locations where the concrete section is not sufficient to provide a minimum clear distance of 2 inches between the splice and the nearest adjacent bar.
   
d. The clearance to the surface of the concrete specified on the Plans shall not be reduced.

7. Service Splicing and Ultimate Butt Splicing Requirements:
   
a. Service splices and ultimate butt splices shall be either butt welded or mechanical splices, shall be used at the locations shown on the plans, and shall conform to the requirements of these Specifications and the Plans.

8. Mechanical Splices:
   
a. Mechanical splices shall not be used for any reinforcing steel in the “Ultimate Splice Zone” as indicated on the Plans.
   
b. Any mechanical splices proposed by the Contractor shall be submitted for review and approval by the Engineer prior to reinforcing steel fabrication.
   
c. Only mechanical splices prequalified by the Transportation Laboratory of the California Department of Transportation shall be allowed.
   
d. Submittal of proposed mechanical splices shall include:
1) The type or series identification of the splice material including tracking information for traceability.

2) The bar grade and size number to be spliced.

3) A copy of the manufacturer’s product literature giving complete data on the splice material and installation procedures.

4) A statement that the splicing systems and materials used in conformance with the manufacturer’s installation procedures will develop the required tensile strengths, based on the nominal bar area, and will conform to the total slip requirements and the other requirements in the California Department of Transportation Standard Specifications.

5) A statement that the splice material conforms to the type of mechanical splice in the California Department of Transportation current prequalified list.

9. Butt Welded Splices:

a. Except for resistance butt welds, butt welded splices of reinforcing bars shall be complete joint penetration butt welds conforming to the requirements in AWS D 1.4, and these Specifications.

b. Welders and welding procedures shall be qualified in conformance with the requirements in AWS D 1.4.

c. Only the joint details and dimensions as shown in Figure 3.2, "Direct Butt Joints," of AWS D 1.4, shall be used for making complete joint penetration butt welds of bar reinforcement.

1) Split pipe backing shall not be used.

d. Butt welds shall be made with multiple weld passes using a stringer bead without an appreciable weaving motion.

1) The maximum stringer bead width shall be 2.5 times the diameter of the electrode and slagging shall be performed between each weld pass.

2) Weld reinforcement shall not exceed 0.16 inches in convexity.

e. Electrodes used for welding shall meet the minimum Charpy V-notch impact requirement of 27°J at -4 degrees.

f. All bars to be welded shall conform to the requirements of ASTM A706.
g. In the event that any of the specified preheat, interpass, and post weld cooling temperatures are not met, all weld and heat affected zone metal shall be removed and the splice rewelded.

h. Welding shall be protected from air currents, drafts, and precipitation to prevent loss of heat or loss of arc shielding.

1) The method of protecting the welding area from loss of heat or loss of arc shielding shall be subject to approval by the Engineer.

i. Reinforcing bars shall not be direct butt spliced by thermite welding.

j. Procedures to be used in making welded splices in reinforcing bars, and welders employed to make splices in reinforcing bars, shall be qualified by tests performed by the Contractor on sample splices of the type to be used, before making splices to be used in the work.

10. Resistance Butt Welding:

a. Shop produced resistance butt welds shall be produced by a fabricator who is approved by the Transportation Laboratory of the California Department of Transportation.

b. Before manufacturing hoops using resistance butt welding, the Contractor shall submit to the Engineer the manufacturer’s Quality Control (QC) manual for the fabrication of hoops.

1) As a minimum, the QC manual shall include the following:

a) The pre-production procedures for the qualification of material and equipment.

b) The methods and frequencies for performing QC procedures during production.

c) The calibration procedures and calibration frequency for all equipment.


e) The method for identifying and tracking lots.

11. Service Splice and Ultimate Butt Splice Testing Requirement:

a. Testing and reporting of test results for Service and Ultimate Butt Splices shall conform to the California Department of Transportation Standard Specification, Section 52 Reinforcement.
F. Placing Rebars:

1. Assure that reinforcement at time concrete is placed is free of mud, oil or other materials that may affect or reduce bond.

2. Reinforcement with rust, mill scale or a combination of both will be accepted as being satisfactory without cleaning or brushing provided dimensions and weights including heights of deformations on a cleaned sample is not less than required by applicable ASTM Specification that governs for the rebar supplied.

3. Rebar support:
   a. Uncoated rebar:
      1) Support rebars and fasten together to prevent displacement by construction loads or placing of concrete.
         a) Locate and support reinforcement with bar supports to maintain minimum concrete cover.
         b) Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
      2) On ground, provide supporting concrete blocks to support reinforcing steel.
      3) Over formwork, provide plastic-coated metal chairs, runners, bolsters, spacers, hangers and other rebar support.
         a) Only tips in contact with the forms need to be plastic coated.
   b. Coated rebar:
      1) Support coated rebars and fasten together to prevent displacement.
      2) Use plastic or nylon ties to hold rebars rigidly in place.
      3) Support rebars by use of plastic or plastic-coated chairs, runners, bolsters, spacers, hangers and rebar supports as required.

4. Support rebars over cardboard void forms by means of concrete supports which will not puncture or damage the void forms during construction nor impair the strength of the concrete members in any way.
5. Where parallel horizontal reinforcement in beams is indicated to be placed in two or more layers, rebars in the upper layers shall be placed directly above rebars in the bottom layer with clear distance between layers to be 1 inches.
   a. Place spacer rebars at 3 feet maximum centers to maintain the required 1 inches clear distance between layers.

6. Extend reinforcement to within 2 inches of concrete perimeter edges.
   a. If perimeter edge is formed by earth, extend reinforcement to within 3 inches of the edge.

7. To assure proper placement, furnish templates for all column/pier vertical bars and dowels.

8. Do not bend reinforcement after embedding in hardened concrete unless approved by Engineer.
   a. Do not bend reinforcing by means of heat.

9. Do not tack weld reinforcing.

10. Embed rebars into hardened concrete utilizing adhesive anchor system specifically manufactured for such installation:
    a. Drill hole in concrete with diameter and depth as required to develop 125 percent of the yield strength of the bar according to manufacturer's requirements.
    b. Clean holes per manufacturer's recommendations.
    c. Place adhesive in drilled hole.
    d. Insert rebar into hole and adhesive in accordance with manufacturer's instructions.

3.02 FIELD QUALITY CONTROL

A. Reinforcement Congestion and Interferences:

1. Notify Engineer whenever the specified clearances between rebars cannot be met.

2. Do not place any concrete until the Engineer submits a solution to rebar congestion problem.

3. Rebars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items.

4. If rebars are moved more than one bar diameter, obtain Engineer's approval of resulting arrangement of rebars.
5. No cutting of rebars shall be done without written approval of Engineer.

B. Inspection of Epoxy-Coated Rebars:

1. Coated rebars will be inspected on the jobsite for handling defects, coating abrasion, coating thickness and continuity of coating.

2. Engineer may defer final inspection of rebar coating integrity and repairs until the rebars have been erected and all handling is completed.

3. Repair coated areas as directed by Engineer.
   a. Do not place concrete until all repairs to coatings have been completed.

C. Patching of Epoxy-Coated Rebar:

1. Patching and repair to be performed in accordance with the instructions of patching material manufacturer.

2. Patching material to provide a minimum film thickness of 5 mils over the bare area.
   a. Thickness of area adjacent to patched area not to exceed 15 mils.

3. Areas to be patched to be clean and free of surface contaminants.
   a. Treat areas in accordance with patching material manufacturer's instructions before oxidation occurs.

4. Total surface area covered by patching material not to exceed 2 percent of total surface area of the rebar.

5. Rebar welds and adjacent bare rebar areas to also be patched after welding is completed.

D. Employ a testing laboratory to perform and report following:

1. Review and approve Contractor proposed welding procedures and processes for conformance with AWS D1.4.

2. Qualify welders in accord with AWS D1.4.

3. Test three (3) samples of each bar size and each type of weld in accord with AWS D1.4.
   a. The tensile strength of each test shall be not less than 125 percent of the required yield strength of the rebar tested.
4. Conduct nondestructive field tests (radiographic or magnetic particle) on not less than one (1) random sample for each 10 welds.
   a. In addition if any welds are found defective, test five (5) previous welds performed by same welder.

5. Visually inspect each weld for presence of cracks, undercuts, inadequate size and other visible defects.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Reinforcing Steel will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. If a nominal weight is not available, steel will be assumed to have a unit weight of 490 lbs per cu ft of volume.

4.02 PAYMENT

A. Reinforcing Steel furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Full compensation for furnishing all tie wires, blocks, chairs and other supporting devices shall be considered as included in the contract Unit Price by the unit and no separate payment will be made therefore.

C. Full compensation for furnishing and testing sample splices, for radiographic examinations performed by the Contractor and for furnishing access facilities for inspection and non-destructive testing by the Engineer shall be considered as included in the Contract Unit Price by the unit and no additional compensation will be allowed therefore.
SECTION 03 31 00

STRUCTURAL CONCRETE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 03 21 00 – Reinforcing Steel.

1.02 REFERENCES

A. American Railway Engineering and Maintenance-of-Way Association (AREMA)
   1. Chapter 8 – Concrete Structures and Foundations

B. American Concrete Institute (ACI):
   1. 116R, Cement and Concrete Terminology.
   2. 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
   3. 212.3R, Chemical Admixtures for Concrete.
   5. 304.2R, Placing Concrete by Pumping Methods.
   7. 306R, Cold Weather Concreting.
   8. 318, Building Code Requirements for Structural Concrete.
   9. 347R, Recommended Practice for Concrete Formwork.
C. ASTM International (ASTM):

5. C138, Standard Method of Test for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
11. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
17. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.


D. Corps of Engineers (COE):


1.03 DEFINITIONS

A. Per ACI 116R except as modified herein:


2. Concrete Testing Agency: Testing agency employed to perform materials evaluation, design of concrete mixes or testing of concrete placed during construction.

3. Exposed concrete: Exposed to view after construction is complete.


5. Nonexposed concrete: Not exposed to view after construction is complete.


7. Specified strength: Specified compressive strength at 28 days.

8. Submitted: Submitted to Engineer.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Division 01 for requirements for the mechanics and administration of the submittal process.

2. Concrete mix designs proposed for use.
a. Concrete mix design submittal to include the following information:

1) Sieve analysis and source of fine and coarse aggregates.
2) Test for aggregate organic impurities.
3) Test for deleterious aggregate per ASTM C289.
4) Proportioning of all materials.
5) Type of cement with mill certificate for cement.
6) Type of fly ash with certificate of conformance to Specification requirements.
7) Slump.
8) Air content.
9) Brand, type, ACI or ASTM designation, and quantity of each admixture proposed for use.
10) 28-day cylinder compressive test results of trial mixes per ACI 318 and as indicated herein.
11) Shrinkage test results.
12) Standard deviation value for concrete production facility.

3. Product technical data including:

a. Acknowledgement that products submitted meet requirements of standards referenced.

b. Manufacturer's installation instructions.

c. Manufacturers and types:

1) Joint fillers.
2) Curing agents.
3) Bonding and patching mortar.
4) Construction joint bonding adhesive.
5) Non-shrink grout with cure/seal compound.

4. Reinforcing steel:

a. Per Specification Section 03 21 00.
1.05 QUALITY ASSURANCE

A. Quality Assurance:

1. Concrete testing agency:
   a. Contractor must employ at its own expense the services of a testing laboratory to:
      1) Perform materials evaluation.
      2) Design concrete mixes.
   b. Concrete testing agency to meet requirements of ASTM E329.

2. Do not begin concrete production until proposed concrete mix design has been approved by Engineer.
   a. Approval of concrete mix design by Engineer does not relieve Contractor of his responsibility to provide concrete that meets the requirements of this Specification.

3. Adjust concrete mix designs when material characteristics, job conditions, weather, strength test results or other circumstances warrant.
   a. Do not use revised concrete mixes until submitted to and approved by Engineer.

4. Perform structural calculations as required to prove that all portions of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its own weight plus the loads placed thereon.

B. Qualifications:

1. Ready mixed concrete batch plant certified by National Ready Mixed Concrete Association (NRMCA).

2. Formwork, shoring and reshoring for slabs and beams except where cast on ground to be designed by a professional engineer currently registered in the state where the Project is located.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Storage of Material:

1. Cement and fly ash:
   a. Store in moistureproof, weathertight enclosures.
   b. Do not use if caked or lumpy.
2. Aggregate:
   a. Store to prevent segregation and contamination with other sizes or foreign materials.
   b. Obtain samples for testing from aggregates at point of batching.
   c. Do not use frozen or partially frozen aggregates.
   d. Do not use bottom 6 inches of stockpiles in contact with ground.
   e. Allow sand to drain until moisture content is uniform prior to use.

3. Admixtures:
   a. Protect from contamination, evaporation, freezing, or damage.
   b. Maintain within temperature range recommended by manufacturer.
   c. Completely mix solutions and suspensions prior to use.

4. Reinforcing steel: Support and store all rebars above ground.

B. Delivery:

1. Concrete:
   a. Prepare a delivery ticket for each load for ready-mixed concrete.
   b. Truck operator shall hand ticket to Engineer at the time of delivery.
   c. Ticket to show:
      1) Mix identification mark.
      2) Quantity delivered.
      3) Amount of each material in batch.
      4) Outdoor temp in the shade.
      5) Time at which cement was added.
      6) Numerical sequence of the delivery.
      7) Amount of water added.
PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following products and manufacturers are acceptable:

1. Nonshrink, nonmetallic grout:
   a. Sika "SikaGrout 212."
   b. Euclid Chemial "NS Grout."
   c. BASF Admixtures, Inc. "Masterflow 713."

2. Epoxy grout:
   a. BASF Admixtures, Inc. "Brutem MPG."
   b. Euclid Chemical Company, "E3-G."
   c. Fosroc, "Conbextra EPHF."

3. Expansion joint fillers:
   a. Permaglaze Co.
   b. Rubatex Corp.
   c. Williams Products, Inc.

4. Form coating:
   a. Richmond "Rich Cote."
   b. Industrial Lubricants "Nox-Crete Form Coating."
   c. Euclid Chemical "Eucoslip VOX."

5. Prefabricated forms:
   a. Simplex "Industrial Steel Frame Forms."
   b. Symons "Steel Ply."
   c. Universal "Uniform."

6. Bonding agent:
   a. Euclid Chemical Co.
b. BASF Admixtures, Inc.
c. L & M Construction Chemicals Inc.

7. Calcium nitrate:
   a. Grace Concrete Products.
      1) DCI.
      2) DCI'S.
   b. Euclid Chemical Company.
      1) Eucon BCN.
      2) Eucon CIA.

8. Microsilica (Silica Fume):
   a. Grace Concrete Products "Force 10,000 D".
   b. Euclid Chemical Company "Eucon MSA".

B. Submit request for substitutions in accordance with Division 01.

2.02 MATERIALS

A. Portland Cement: Conform to ASTM C150 Type II, III or V.

B. Fly Ash:
   1. ASTM C618, Class F or Class C.
   2. Non-Staining.
      a. Hardened concrete containing fly ash to be uniform light gray color.
   3. Maximum loss on ignition: 4 percent.
   4. Compatible with other concrete ingredients.
   5. Obtain proposed fly ash from a source approved by the State Highway Department in the State of California for use in concrete for bridges. A list of pre-approved products may be obtained from the following website: http://www.dot.ca.gov/hq/esc/approved_products_list/

C. Admixtures:
2. Water reducing, retarding, and accelerating admixtures:
   a. ASTM C494 Type A through E.
   b. Conform to provisions of ACI 212.3R.
   c. Do not use retarding or accelerating admixtures unless specifically approved in writing by Engineer and at no cost to SCRRA.
   d. Follow manufacturer’s instructions.
   e. Use chloride free admixtures only.

3. Maximum total water soluble chloride ion content contributed from all ingredients of concrete including water, aggregates, cementitious materials and admixtures by weight percent of cement:
   a. 0.10 all concrete.

4. Do not use calcium chloride.

5. Pozzolanic admixtures: ASTM C618.

6. Calcium nitrate: ASTM C494 Type C.


8. Provide admixtures of same type, manufacturer and quantity as used in establishing required concrete proportions in the mix design.

D. Water: Potable, clean, free of oils, acids and organic matter.

E. Aggregates:

1. Normal weight concrete: ASTM C33, except as modified below.

2. Fine aggregate:
   a. Clean natural sand.
   b. No manufactured or artificial sand.

3. Coarse aggregate:
   a. Crushed rock, natural gravel, or other inert granular material.
   b. Maximum amount of clay or shale particles: 1 percent.

4. Gradation of coarse aggregate:
   a. Lean concrete and concrete topping: Size #7 or #8.
b. All other concrete: Size #57 or #67.

F. Concrete Grout:

1. Nonshrink nonmetallic grout:
   a. Nonmetallic, noncorrosive, nonstaining, premixed with only water to be added.
   b. Grout to produce a positive but controlled expansion.
   c. Mass expansion not to be created by gas liberation.
   d. Minimum compressive strength of non-shrink grout at 28 days: 6500 psi.
   e. In accordance with COE CRD-C621.

2. Epoxy grout:
   a. 3-component epoxy resin system.
      1) Two liquid epoxy components.
      2) One inert aggregate filler component.
   b. Each component packaged separately for mixing at jobsite.
   c. Minimum compressive strength of epoxy grout shall be as specified in the Plans.

G. Forms:

1. Prefabricated or job built.

2. Wood forms:
   a. New 5/8 or 3/4 inches 5-ply structural plywood of concrete form grade.
   b. Built-in-place or prefabricated type panel.
   c. 4 x 8 feet sheets for built-in-place type except where smaller pieces will cover entire area.
   d. When approved, plywood may be reused.

3. Metal forms:
   a. Metal forms excluding aluminum may be used.
b. Forms to be tight to prevent leakage, free of rust and straight without dents to provide members of uniform thickness.


5. Form ties:
   a. Removable end, permanently embedded body type with cones on outer ends not requiring auxiliary spreaders.
   b. Cone diameter: 3/4 inches minimum to 1 inch maximum.
   c. Embedded portion 1-1/2” minimum back from concrete face.
   d. If not provided with threaded ends, constructed for breaking off ends without damage to concrete.
   e. Provide ties with built-in waterstops at all walls that will be in contact with process liquid during plant operation.

6. Form release: Nonstaining and shall not prevent bonding of future finishes to concrete surface.

H. Membrane Curing Compound:
   1. ASTM C309, Type I-D.
   2. Resin based, dissipates upon exposure to UV light.
   3. Curing compound shall not prevent bonding of any future coverings, coatings or finishes.
   4. Curing compounds used in water treatment plant construction to be nontoxic and taste and odor free.

I. Bonding Agent:
   1. High solids acrylic latex base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.
   2. Euclid Chemical Co. "Flex-Con."
   3. BASF Admixtures, Inc. "Acryl-Set."
   4. L & M Construction Chemicals "Everbond."
   5. Thoro System Products "Acryl 60."

J. Expansion Joint Filler:
1. In contact with water or sewage:
   a. Closed cell neoprene.
   b. ASTM D1056, Class SC (oil resistant and medium swell) of 2 to 5 psi compression deflection (Grade SCE41).

2. Exterior walking surfaces:
   a. Asphalt expansion joint filler.
   b. ASTM D994.

3. Other use:
   a. Fiber expansion joint filler.
   b. ASTM D1751.

K. Bead Board

1. The bead board panels shall be a minimum of two (2) inch thick, four (4) feet wide, and 8 feet long and shall meet the requirements of ASTM C578.

2. Bead board coat: A suitable and compatible bonding material for permanently adhering.

2.03 CONCRETE MIXES

A. General:

1. All concrete to be ready mixed concrete conforming to ASTM C94.

2. Provide concrete of specified quality capable of being placed without segregation and, when cured, of developing all properties required.

3. All concrete to be normal weight concrete.

B. Strength:

1. Provide specified strength and type of concrete for each use in structure(s) as follows:
### Type of Construction

<table>
<thead>
<tr>
<th>Concrete Class*</th>
<th>Maximum Slump (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Street Surface Improvements</strong></td>
<td></td>
</tr>
<tr>
<td>Concrete Pavement (not integral with curb)</td>
<td>565-C-3250</td>
</tr>
<tr>
<td>Curb, Integral Curb and Pavement, Gutter, Walk, Alley Aprons, Extruded Curb &amp; Gutter</td>
<td>565-C-3250</td>
</tr>
<tr>
<td><strong>Sewer and Storm Drainage Facilities</strong></td>
<td></td>
</tr>
<tr>
<td>Pipe Collars, Beam Support for Pipe, Pre-Cast Manhole Components, Catch Basins, Sidewalk Culverts</td>
<td>565-C-3250</td>
</tr>
<tr>
<td>Pipe Bedding and Encasement, Anchors and Thrust Blocks, Wall Support for Pipe</td>
<td>520-C-2500</td>
</tr>
<tr>
<td>Tunnel and Trench Backfill</td>
<td>520-C-2500</td>
</tr>
<tr>
<td><strong>Reinforced Structures</strong></td>
<td></td>
</tr>
<tr>
<td>Bridges, Buildings, Retaining Walls</td>
<td>650-CW-4000</td>
</tr>
<tr>
<td>Cast-In-Place Piles</td>
<td>650-CW-4000</td>
</tr>
<tr>
<td>Channel and Boxes</td>
<td>650-CW-4000</td>
</tr>
<tr>
<td>Walls and Deck</td>
<td>650-CW-4000</td>
</tr>
<tr>
<td><strong>Miscellaneous</strong></td>
<td></td>
</tr>
<tr>
<td>Street Light and Traffic Signal Foundations, Survey Monuments</td>
<td>565-C-3250</td>
</tr>
<tr>
<td>Fence and Guard Post Foundations</td>
<td>565-C-3250</td>
</tr>
<tr>
<td>Coarse Masonry Grout</td>
<td>610-E-2000G</td>
</tr>
</tbody>
</table>

*Refer to SSPWC Section 201 for designation.

C. Air Entrainment:

1. Provide air entrainment in all concrete resulting in a total air content percent by volume as follows:

<table>
<thead>
<tr>
<th>MAX AGGREGATE SIZE</th>
<th>TOTAL AIR CONTENT PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch or 3/4 inches</td>
<td>5 to 7</td>
</tr>
</tbody>
</table>
2. Air content to be measured in accordance with ASTM C231, ASTM C173, or ASTM C138.

D. Slump - 4 inches maximum, 1 inch minimum:
   1. Measured at point of discharge of the concrete into the concrete construction member.
   2. Concrete of lower than minimum slump may be used provided it can be properly placed and consolidated.
   3. Pumped concrete:
      a. Provide additional water at batch plant to allow for slump loss due to pumping.
      b. Provide only enough additional water so that slump of concrete at discharge end of pump hose does not exceed maximum slump specified above.
   4. Determine slump per ASTM C143.

E. Selection of Proportions:
   1. General:
      a. Proportion ingredients to:
         1) Produce proper workability, durability, strength, and other required properties.
         2) Prevent segregation and collection of excessive free water on surface.
   2. Minimum cement contents and maximum water cement ratios for concrete to be as follows:

<table>
<thead>
<tr>
<th>SPECIFIED STRENGTH</th>
<th>MINIMUM CEMENT, LB/CY</th>
<th>MAXIMUM AGGREGATE SIZE</th>
<th>MAXIMUM WATER CEMENT RATIO BY WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>4000</td>
<td>650</td>
<td>650</td>
<td>650</td>
</tr>
</tbody>
</table>

3. Substitution of fly ash: Maximum of 25 percent by weight of cement at rate of 1 lb fly ash for 1 lb of cement.

4. Sand cement grout:
a. Three parts sand.

b. One part Portland cement.

c. Entrained air: Six percent plus or minus one percent.

d. Sufficient water for required workability.

e. Minimum 28-day compressive strength: 3,000 psi.

5. Normal weight concrete:

a. Proportion mixture to provide desired characteristics using one of methods described below:

1) Method 1 (Trial Mix): Per ACI 318, Chapter 5, except as modified herein.
   a) Air content within range specified above.
   b) Record and report temperature of trial mixes.
   c) Proportion trial mixes per ACI 211.1.

2) Method 2 (Field Experience): Per ACI 318, Chapter 5, except as modified herein:
   a) Field test records must be acceptable to Engineer to use this method.
   b) Test records shall represent materials, proportions and conditions similar to those specified.

6. Required average strength to exceed the specified 28-day compressive strength by the amount determined or calculated in accordance with the requirements of Paragraph 5.3 of ACI 318 using the standard deviation of the proposed concrete production facility as described in Paragraph 5.3.1 of ACI 318.

F. Allowable Shrinkage: 0.048 percent per ASTM C157.

G. For Brackish or Salt Water Locations:

1. Calcium nitrate shall be added at a quantity of 5 gal per cubic yard.
   a. Calcium nitrite solution shall contain 30 percent solids and shall provide 15 lbs per cubic yard chloride protection.
   b. Mix shall also include 7 percent, by weight of cement microsilica.
2. Proposed admixture alternates must be approved by the SCRRRA prior to their use.
   a. Any proposed substitution shall include:
      1) Documentation as to the corrosion protection mechanism.
      2) Test data documenting the stated level of protection offered.
      3) Documentation that the proposed alternate meets a service life of 100 years as calculated using Fick’s Second Law of Physics.
   b. All models shall use a reference diffusion coefficient of 2.81.

3. The Contractor may perform trial mixes prior to the delivery in order to adjust the desired air content, set time, and slump.

PART 3 - EXECUTION

3.01 FORMING AND PLACING CONCRETE

A. Formwork:
   1. Contractor is responsible for design and erection of formwork.
   2. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation and position.
      a. Allowable tolerances: As recommended in ACI 347R.
   3. Chamfer strips: Place ¾” chamfer strips in forms to produce ¾” wide beveled edges on permanently exposed corners of members.
   4. Clean and adjust forms prior to concrete placement.
   5. Tighten forms to prevent mortar leakage.
   6. Coat form surfaces with form release agents prior to placing reinforcing bars in forms.

B. Construction, Expansion, and Contraction Joints:
   1. Provide at locations indicated.
   2. Locate construction joints in beams and girders as shown in the Plans.
   3. Install construction joints perpendicular to main reinforcement with all reinforcement continued across construction joints.
4. At least 48 hours shall elapse between placing of adjoining concrete construction.

5. Thoroughly clean and remove all laitance and loose and foreign particles from construction joints.

6. Before new concrete is placed, existing concrete surfaces must be roughened to ¼” amplitude and coat all construction joints with an approved bonding adhesive used and applied in accordance with manufacturer’s instructions.

C. Embedments:

1. Set and build in anchorage devices and other embedded items required for other work that is attached to, or supported by concrete.

2. Use setting diagrams, templates and instructions for locating and setting.

3. Secure waterstops in correct position using hog rings or grommets spaced along the length of the waterstop and wire tie to adjacent reinforcing steel.

D. Placing Concrete:

1. Place concrete in compliance with ACI 304R and ACI 304.2R.

2. Place in a continuous operation within planned joints or sections.

3. Begin placement when work of other trades affecting concrete is completed.

4. Place concrete by methods which prevent aggregate segregation.

5. Do not allow concrete to free fall more than 4 feet.

6. Where free fall of concrete will exceed 4 feet, place concrete by means of tremie pipe or chute.

E. Consolidation: Consolidate all concrete using mechanical vibrators supplemented with hand rodding and tamping, so that concrete is worked around reinforcement and embedded items into all parts of forms.

F. Protection:

1. Protect concrete from physical damage or reduced strength due to weather extremes.

2. In cold weather comply with ACI 306R except as modified herein.

   a. Do not place concrete on frozen ground or in contact with forms or reinforcing bars coated with frost, ice or snow.
b. Minimum concrete temperature at the time of mixing:

<table>
<thead>
<tr>
<th>OUTDOOR CONCRETE TEMPERATURE AT PLACEMENT (IN SHADE)</th>
<th>MIXING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 30˚ F</td>
<td>70˚ F</td>
</tr>
<tr>
<td>Between 30˚-45˚ F</td>
<td>60˚ F</td>
</tr>
<tr>
<td>Above 45˚ F</td>
<td>50˚ F</td>
</tr>
</tbody>
</table>

c. Do not place heated concrete that is warmer than 80 DegF.

d. If freezing temperatures are expected during curing, maintain the concrete temperature at or above 50˚ F for 7 days or 70˚ F for 3 days.

e. Do not allow concrete to cool suddenly.

3. In hot weather comply with ACI 305R except as modified herein.

a. At air temperature of 90˚ F and above, keep concrete as cool as possible during placement and curing.

b. Do not allow concrete temperature to exceed 90˚ F at placement.

c. Prevent plastic shrinkage cracking due to rapid evaporation of moisture.

d. Do not place concrete when the actual or anticipated evaporation rate equals or exceeds 0.2 lbs/sf/hr as determined from ACI 305R, Figure 2.1.5.

G. Curing:

1. Begin curing concrete as soon as free water has disappeared from exposed surfaces.

2. Cure concrete by use of moisture retaining cover, burlap kept continuously wet or by membrane curing compound.

3. Provide protection as required to prevent damage to concrete and to prevent moisture loss from concrete during curing period.

4. Provide curing for minimum of 7 days.

5. Form materials left in place may be considered as curing materials for surfaces in contact with the form materials except in periods of hot weather.

6. In hot weather follow curing procedures outlined in ACI 305R.
7. In cold weather follow curing procedures outlined in ACI 306R.

8. If forms are removed before 7 days have elapsed, finish curing of formed surfaces by one of above methods for the remainder of the curing period.

9. Curing vertical surfaces with a curing compound:
   a. Cover vertical surfaces with a minimum of two coats of the curing compound.
   b. Allow the preceding coat to completely dry prior to applying the next coat.
   c. Apply the first coat of curing compound immediately after form removal.
   d. Vertical surface at the time of receiving the first coat shall be damp with no free water on the surface.
   e. A vertical surface is defined as any surface steeper than 1 vertical to 4 horizontal.

H. Form Removal:
   1. Remove forms after concrete has hardened sufficiently to resist damage from removal operations or lack of support but no sooner than 3 days after placement of concrete.

3.02 CONCRETE FINISHES

A. Surfaces Exposed to View:
   1. Provide a smooth finish for exposed concrete surfaces.
   2. Remove fins and projections, and patch voids, air pockets, and honeycomb areas with cement grout.
   3. Fill tie holes with nonshrink nonmetallic grout.

B. Surfaces Not Exposed to View:
   1. Patch voids, air pockets and honeycomb areas with cement grout.
   2. Fill tie holes with nonshrink nonmetallic grout.

C. Troweled Finish:
   1. Float finish surface.

D. Broom Finish: Immediately after concrete has received a float finish as specified, give it a transverse scored texture by drawing a broom across surface.
3.03 GROUT

A. Preparation:

1. Nonshrinking nonmetallic grout:
   a. Clean concrete surface to receive grout.
   b. Saturate concrete with water for 24 hours prior to grouting.

2. Epoxy grout: Apply only to clean, dry, roughened, sound surface.

B. Application:

1. Nonshrinking nonmetallic grout:
   a. Mix in a mechanical mixer.
   b. Use no more water than necessary to produce flowable grout.
   c. Place in accordance with manufacturer's instructions.
   d. Completely fill all spaces and cavities below the bottom of baseplates.
   e. Provide forms where baseplates and bedplates do not confine grout.
   f. Where exposed to view, finish grout edges smooth.
   g. Except where a slope is indicated on Plans, finish edges flush at the baseplate, bedplate, member, or piece of equipment.
   h. Protect against rapid moisture loss by covering with wet rags or polyethylene sheets.
   i. Wet cure grout for seven (7) days, minimum.

2. Epoxy grout:
   a. Mix and place in accordance with manufacturer's instructions.
   b. Completely fill all cavities and spaces around dowels and anchors without voids.
   c. Obtain manufacturer's field technical assistance as required to ensure proper placement.
3.04 FIELD QUALITY CONTROL

A. SCRRRA will select a concrete testing agency that meets ASTM C1077-12 criteria and requirements. The Contractor will pay for services of a concrete testing agency to perform testing of concrete placed during construction.

1. Contractor to cooperate with SCRRRA in obtaining and testing samples.

B. Tests During Construction:

1. Strength test - procedure:

   a. Three cylinders, 6 inches dia. x 12 inches high, will be taken from each sample per ASTM C172 and ASTM C31.

   b. Cylinders will be tested per ASTM C39:

      1) One at 7 days.

      2) Two at 28 days.

2. Strength test - frequency:

   a. Not less than one test each day concrete placed.

   b. Not less than one test for each 50 cy or major fraction thereof placed in one day.

   c. Not less than one test for each type of concrete poured.

   d. Not less than one test for each concrete structure exceeding 2 cy volume.

3. Slump test:

   a. Per ASTM C143.

   b. Determined for each strength test sample.

   c. Additional slump tests may be taken.

4. Air content:


   b. Determined for each strength test sample.

5. Temperature: Determined for each strength test sample.

C. Evaluation of Tests:
1. Strength test results:
   a. Average of 28-day strength of two cylinders from each sample.
      1) If one cylinder manifests evidence of improper sampling, molding, handling, curing or testings, strength of remaining cylinder will be test result.
      2) If both cylinders show any of above defects, test will be discarded.

D. Acceptance of Concrete:
1. Strength level of each type of concrete shall be considered satisfactory if both of the following requirements are met:
   a. Average of all sets of three consecutive strength tests equals or exceeds the required specified 28-day compressive strength.
   b. No individual strength test falls below the required specified 28-day compressive strength by more than 500 psi.
2. If tests fail to indicate satisfactory strength level, perform additional tests and/or corrective measures as directed by Engineer.
   a. Perform additional tests and corrective measures at no additional cost to SCRRA.

3.05 SCHEDULES
A. Form Types:
1. Surfaces exposed to view:
   a. Prefabricated or job-built wood forms.
   b. Laid out in a regular and uniform pattern with long dimensions vertical and joints aligned.
   c. Produce finished surfaces free from offsets, ridges, waves, and concave or convex areas.
   d. Construct forms sufficiently tight to prevent leakage of mortar.
2. Surfaces normally submerged or not normally exposed to view: Wood or steel forms sufficiently tight to prevent leakage of mortar.
3. Other types of forms may be used:
   a. For surfaces not restricted to plywood or lined forms.
b. As backing for form lining.

B. Grout:

1. Nonshrinking nonmetallic grout: General use.
2. Epoxy grout:
   a. Grouting of dowels and anchor bolts into existing concrete.
   b. Other uses indicated on Plans.

C. Concrete Finishes:

1. Unformed surfaces:
   a. Use following finishes as applicable, unless otherwise indicated:
      1) Troweled finish: All unformed surfaces.
      2) Broom finish: All walking surfaces.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Concrete Structures will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Precast Concrete Members will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

C. Concrete Pavement will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

D. Concrete in structures will be measured by the neat line dimensions shown on the Plans or such other dimensions as may be ordered by the Engineer. No deduction will be made for the volume occupied by bar reinforcing steel or other embedded steel items.
E. Precast Concrete Members will be measured by the various types and lengths shown in Contract Documents and for erecting the members as shown in the Contract Documents.

F. Concrete Pavement area to be paid for will be calculated on the basis of the dimensions shown on the Plans adjusted by the amount of any change ordered by the Engineer. No allowance will be made for concrete pavement placed outside those dimensions unless otherwise ordered by the Engineer.

G. Concrete and Concrete Aggregate Testing for field quality control conducted by the testing agency selected by SCRRRA is considered incidental to work under other payment items under this Section and no separate measurement and payment will be made to the Contractor.

4.02 PAYMENT

A. Concrete Structures furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Precast Concrete Members furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

C. Concrete Pavement furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

D. Contract Unit Price for concrete structures shall include full compensation for all work involved in constructing the concrete work, complete-in-place, as shown on the Plans, as specified in these Specifications and as directed by the Engineer.

E. The contract Unit Price for concrete structures shall include full compensation for all forming and shoring, joints, joint filler, joint seals and waterstops necessary for constructing the concrete work complete-in-place.

F. The Contract Unit Price for concrete in reinforced concrete box and culverts, and in headwalls, endwalls, and wingwalls for culverts shall also include the payment for the earthwork involved with such structures.
G. The Contract Unit Price paid for furnishing precast concrete members shall include full compensation for including reinforcing and prestressing steel as required, and for doing all work involved in constructing and furnishing precast members at the site of the work complete and ready for erection, as shown on Plans, and as specified in these Specifications, and as directed by the Engineer.

H. Concrete pavement shall be constructed in accordance with the thickness requirements of the Plans and Specifications. Tolerances allowed for subgrade construction and other provisions of these Specifications which may affect the thickness shall not be construed to modify those thickness requirements.

I. All holes remaining in the concrete pavement after the thickness measurements, if required, shall be completely filled by the Contractor, at the Contractor's expense.

J. No additional compensation will be allowed the Contractor for any pavement constructed in excess of the thickness requirements of the Plans and Specifications.

K. Concrete and Concrete Aggregate Testing shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 04 22 00
CONCRETE UNIT MASONRY

PART 1 – GENERAL

1.01 SUMMARY

A. Section includes:

1. Furnish and lay concrete masonry units.
2. Furnish and place reinforcing steel.
3. Provide mortar, grout and grouting.
4. Place bolts, anchors, hardware, metal frames and other insert items.
5. Cure, Protect and clean finish work.

B. Related Specification Sections include but not necessarily limited to:

1. Section 03 21 00, Reinforcing Steel
2. Section 03 31 00, Structural Concrete
3. Section 05 55 00, Miscellaneous Metal

1.02 REFERENCES

A. All Work specified herein shall conform to or exceed the applicable requirements of the referenced portions of the following publications to the extent that the provisions thereof are not in conflict with other provisions of these Specifications.


C. CRSI, Concrete Reinforcing Steel Institute.


E. UBC, Uniform Building Code.

F. ASTM C90, Standard Specification for Loadbearing Concrete Masonry Units.
1. ASTM C140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.


1.03 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

1. Samples: Submit 3 samples each of each type of masonry unit required for work to the architect for review prior to ordering, receiving or installing units in field.

2. Submit coursing lay-up pattern of all wall corners, intersections, and pilaster to Architect/Engineer for approval.

1.05 QUALITY ASSURANCE

A. Concrete Masonry units: Sample and test in accordance with ASTM C140.

1. Contractor shall notify the Testing Laboratory a minimum of 45 days in advance of laying concrete unit masonry, to allow for testing of the units for compression, shrinkage and absorption (absorption test requires 40 days).

2. The assigned Material Testing Laboratory shall receive 5 concrete masonry units per test from masonry unit manufacturer (units as designed or specified by the Architect or Engineer), performs and sends required test results to:
a. The city Supervising Structural Engineer  
b. General Contractor  
c. The Commissioned Architect  
d. The Commissioned Structural Engineer  
e. The City Project Architect  
f. The City Construction Inspector

3. Contractor shall reflect time required for testing in Construction Schedule.

B. Portland Cement: Sample and test in accordance with ASTM C150.

C. Mortar: Sample and test in accordance with ASTM C 780

D. Grout: Sample and test in accordance with ASTM C 404.

E. Compressive Tests:
   1. Mortar: Not less than 900 psi at 7 days and 2,800 psi at 28 days.
   2. Grout: Not less than 1,000 psi at 7 days and 2,000 psi at 28 days.
   3. Do not test 28 day specimen when 7 day tests exceed 28 day requirements.

F. Inspection during Laying: A City approved Deputy Inspector will be constantly present during laying of reinforced masonry.

G. Payment for original tests and inspection will be paid by the City. All costs incurred for retests and re-inspections required because of failure of original tests will be paid by the City, charged to Contractor, and deducted from Contract price by Change Order.

H. Should core testing be required by the Structural Engineer or the City, all masonry cut or damaged by coring operation shall be removed and replaced with new masonry to match adjoining work. All costs of removal and replacement shall be borne by Contractor.

1.05 PRODUCT HANDLING

A. Store units above ground on level platforms which allow air circulation under stacked unit.

B. Cover and protect against wetting prior to use.

C. Handle units on pallets or flat bed barrows. Free discharge from conveyor units or transportation in mortar trays not permitted.

PART 2 – PRODUCTS

2.01 MATERIALS
A. Concrete Unit Masonry: Modular medium weight conforming to ASTM C90, grade N-1 (Hollow load-bearing concrete unit masonry). Angelus Block Co. (818) 767-8576

1. Provide open-end units at walls to be grouted.

2. Provide closed-end units at walls and at openings where ends will be exposed in finish work; provide bond beam blocks where horizontal reinforcing is indicated.

3. Provide special shapes and accessory units at locations indicated on Drawings.

4. Except as otherwise specified, provide units in standard gray color.

B. Portland Cement: ASTM C150, Type II, from one source.


D. Grout: ASTM C476.

E. Hydrated Lime: ASTM C207, Type S.

1. Kel-Crete may be substituted for lime, when approved by the Architect and City.

F. Admixture for Grout: Grout Air No. 2 use, as manufactured by Sika Chemical Corporation, must be approved by the Authority, see Section 01 40 00 - Quality Requirements.

G. Water: Potable and fresh.


I. Miscellaneous Materials: As required to complete work.

J. Sampling and testing of mortar, see Section 01 40 00 - Quality Requirements.

PART 3 – EXECUTION

3.01 MORTAR AND GROUT MIXING

A. Mortar

1. Mortar shall be pre-blended SPEC MIX Masonry Mortar, Type S as manufactured by E-Z MIX INC., Sun Valley, CA., conforming to the proportion & Property specification of ASTM C-270.
2. Colored Mortars: Colored Mortar shall be pre-blended SPEC MIX Masonry Mortar Type S, Color to match concrete masonry unit as manufactured by E-Z MIX Inc., Sun Valley, CA., conforming to the proportion & property specification of ASTM C-270.

Colored Mortar custom match samples shall be submitted for approval prior to construction.

B. Grout: Dry, loose volumes. Mix proportions shall be verified by Material Testing Laboratory.

1. Portland cement .................... 1 part

2. Grout sand............................ 2 ¼ parts to 3 parts

3. Pea gravel ............................ 1 to 2 parts

4. Water................................ to produce required consistency

C. Measurements: Proportion by accurate volume measurements. Measure in suitable calibrated devices that can be easily and accurately checked at any time.

1. Add water for workable consistency.

2. Shovel measurements shall not be permitted.

D. Mixing: Place, sand, cement, and water in mixer in that order, while mixer is running; mix for 3 minutes, add lime, and admixture (for grout), and continue mixing until a uniform mass is secured, but in no case less than 10 minutes.

1. Equipment for mixing and handling mortar and grout shall be acceptable to the Architect and the City.

2. Batches of less than one sack of cement, and fractional sack batches will not be permitted.

E. Retempering Time Limit; Retemper on mortar boards, for not less than 3 minutes not more than 10 minutes when required, by adding water into a basin formed by mortar, and working mortar into it. Dashing, or pouring of water over mortar will not be permitted.

1. Do not retemper mortar which has become hard or non-plastic.

2. Discard mortar which has not been used within one-hour after original mixing.
F. Ready-Mix Grout: Grout batched off-site and delivered by mixer truck shall be subject to same procedures and controls as prescribed in UBC. See Section 01 40 00 - Quality Requirements.

3.02 LAYING CONCRETE UNIT MASONRY

A. Workmanship: Erect masonry plumb and true to line; with straight, level joints of uniform thickness. Maintain proper equipment, skilled masons, and adequate supervision. Keep masonry clean during and after laying.

1. Lay-out and incorporate all embedded hardware items.

2. Assist other trades with built-in items which require cutting and fitting of masonry.

3. Cut block units with a steel saw or carborundum wheel. Trowel or chisel cutting will not be permitted.

B. Reinforcing Steel: Place as indicated on Drawings. Except as indicated otherwise, place reinforcement in accordance with Standards of Concrete Reinforcing Steel Institute (CRSI): Conform also to requirements specified in Section 03 21 00 - Reinforcing Steel.

C. Shoring: Provide, in place, temporary shoring for lintels, strong enough to carry load without deflecting. Remove temporary shoring after masonry has been in place 28 days.

D. Laying Block: Clean all dirt and dust from surfaces before laying.

1. Foundation preparation: Sandblast tops of concrete starting surfaces, wash-off by high pressure water jet, and slurry coat surfaces with neat cement grout and bond to masonry as if it were masonry.

2. After bond bed has hardened slightly, spread mortar to required joint thickness. Lay blocks with 3/8" mortar bed on entire horizontal surface. Fill head joint solid, shove tightly to adjoining units. All joints shall be 3/8".
   a. Hold racking to a minimum.
   b. No toothing allowed.
   c. If it becomes necessary to move a unit after it has been set in place, remove the unit, discard the mortar, and re-set the unit in fresh mortar.

3. Anchor Bolts: Provide 1" minimum grout space around all protruding bolts.

4. Bond: Unless otherwise indicated, noted, or specified, lay all units in common running bond.
5. Finish joint Treatment: Unless otherwise indicated, noted, or specified, cut both interior and exterior joints flush, and tool slightly concave to a dense, uniform surface.

6. Grouting: Unless noted otherwise on Drawings, completely fill all cells with grout.

3.03 LOW-LIFT GROUTING (FOR HOLLOW UNIT MASONRY)

A. After mortar in joints has firmly set, cores are cleaned of mortar and debris, reinforcing is properly in place and checked, grout cells in 2'-0". Maximum lifts, using specified pea gravel grout mix.

B. Grout walls sold, without voids.

C. Grout may be placed by pump, tremie or bucket, using hoppers to avoid spilling on exposed surfaces.

D. Place an initial 2'-0" high lift all around thoroughly compact, then place balance of each lift, compacting again through total lift, using hardwood spading sticks or pencil vibrators.

E. Stop grout pours 1-1/2" below top of each lift.

F. Remove and discard spilled grout from upper units before grout can harden.

G. Bracing: Adequately brace walls against wind and other forces during construction.

3.04 HIGH-LIFT GROUTING OPTION (FOR HOLLOW UNIT MASONRY)

A. Contractor may utilize high-lift grouting method, provided following qualifications and requirements are met. High-lift grouting shall apply only to cell sizes available with 8" and wider block units and shall conform to uniform Building Code, Section 2104.6.1.

B. Contractor shall be responsible for any blowouts or displacement of masonry units due to hydrostatic pressures, voids, or ungrouted areas due to bridging of grout or blocking of cells from any cause.

C. Use bond beam units, inverted for start course, and omit alternate blocks or cut openings in alternate face shell on bottom course for cleanouts.

D. Use a hardwood stick to knock off projecting mortar fins. Wash out every cell thoroughly using a water jet which has sufficient force to remove all mortar from the interior of the cells and from reinforcing steel.

E. Plug each cleanout by setting a "soap" in mortar into opening and securely bracing it in place to prevent displacement. If masonry is not exposed in finish work, cleanouts may be formed.
F. Grouting:
   1. Grout masonry cells slid, without voids.
   2. Do not place grout until masonry has set a minimum of 3 days in warm 50° to 85° F. weather or 5 days in cool 35° to 50° F. damp weather.
   3. Pump grout from mixer into grout cell space as rapidly as practical. Discard grout not in place within one hour after water was first added to batch.
   4. Place grout with maximum slump without segregation. Place in continuous pour, in maximum lifts of 4'-0", with approximately 20 minutes elapsed time between any 2 successive lifts.

G. Compacting:
   1. Compact and re-compact grout using ¾” light-weight flexible calbe vibrators.
   2. First compaction shall be completely to bottom of lift immediately after placement, and in case of subsequent lifts, through previously placed lift.
   3. Top lift shall be re-compacted not sooner than 30 minutes after grout has been placed.
   4. Vibrating of reinforcing steel is not permitted.

H. Bracing: Adequately brace walls against wind and other forces during construction.

3.05 CURING, CLEANING AND PROTECTION
   A. Remove all efflorescence and grout stains.
   B. Do not saturate masonry with water for curing or any other purposes.
   C. Where atmosphere is dry, dampen the wall surface with a very light fog spray for 3 days to help cure mortar in joints.
   D. At completion of masonry work, remove all misplaced mortar, grout or other foreign substances, and clean surfaces which will be exposed in finish work with specified cleaner, or with clean water and stiff fiber brushes.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT
A. Concrete Unit Masonry will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Concrete Unit Masonry furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Concrete Unit masonry including concrete foundation, concrete slab, concrete curb, concrete masonry unit walls, reinforcing steel, grout, wood gate doors, flashing, structural steel and preformed metal roof, anchor bolts, hinges, hardware, fasteners, locks, roof drains and incidentals shall be paid for at the Contract Unit Price as listed on the Schedule of Quantities and Prices. This price shall be full compensation for furnishing all labor, Materials, tools, equipment, fees, supplies, supervision, and incidentals necessary for construction of concrete masonry trash enclosure described by the Contract Documents.

END OF SECTION
SECTION 04 22 10
ENVIRONMENTAL PAVING

PART 1 - GENERAL

1.01 DESCRIPTION

A. The work specified in this Section includes providing labor, materials, tools and equipment to furnish and install a permeable concrete paving stone system (Environmental Paving Section) as indicated on the plans and as specified herein.

B. The Environmental Paving Section supplier shall be selected by the Contractor, but shall comply with the intent to provide a structural section that will absorb and detain surface water (Rainfall) that is collected by the track underdrain system, clean water from the oil/water separator system, and runoff from the AC paving section, holding the majority of the water for absorption into the subgrade.

C. The Environmental Paving Section was derived from the “Permeable Interlocking Concrete Pavements” publication by the Interlocking Concrete Pavement Institute (ICPI), and from systems similar to the “Bio-Aquifer Storm System (BASS) supplied by Orco Pavingstones of Riverside, California, located at www.orco.com. This system or an approved equal permeable paving system with nominal ½ inch spacer bars to provide permeability, may be proposed by the Contractor.

In addition to the sample section provided by the representative “BASS” system, the structural section will include an additional sand filter base course composed of 6” of clean concrete sand.

1.02 RELATED WORK

Coordinate the Work of this Section with all other Contract Documents and in particular:

A. Section 03 31 00 – Structural Concrete

B. Section 31 20 00 - Earthwork

C. Section 34 11 27 – Sub-Ballast and Aggregate Base

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM)

1.04 DEFINITIONS

A. Base Course: Layer of open-graded aggregate beneath the bedding course layer, comprised of small- to medium-particle-sized crushed stone (typically 1/2” to 1”). Recommended depth of the base layer shall be four inches (4”), but shall not exceed six inches (6”).
B. Bedding Course: Layer of open-graded aggregate directly beneath the unit pavers, comprised of small particle-sized crushed stone chips (typically 1/4” to 3/8” rock). Also commonly called the “setting bed”. Recommended depth of the bedding course layer shall be two inches (2”).

C. Bundle: Several layers of paver clusters stacked vertically, packaged, and tagged for shipment. Also commonly called a “cube”.

D. Chamfer: A 45 degree beveled edge around the top of a paver unit, usually 1/8” to ¼” wide. It helps prevent edge chipping, and delineates the individual paver units.

E. Cluster: The group of pavers forming a single layer taken from a bundle of pavers or the group of pavers held by the clamp of a paver laying machine.

F. Flats: The portion of the vertical side faces of a paver other than the spacer bars.

G. Laying Face: The working edge of the pavement where the laying of pavers is occurring.

H. Mechanical Installation: The use of specialized machines to lift clusters of pavers from the bundles and place them on the prepared bedding course. These specialized machines are designed specifically for this application.

I. Method Statement: The paver installer’s and manufacturer’s plan for construction and quality control of the pavers.

J. Spacer Bars: Small protrusions on each side of pavers which are used have spacer bars.

K. Sub-base Course: Layer of open-graded aggregate beneath the base course layer, comprised of large particle-sized (typically 2-1/2” to 3”) crushed stone. Depth shall vary depending upon site conditions and specific requirements. Minimum depth of the sub-base course shall be twelve inches (12”).

L. Void Filler: Open-graded aggregate used to fill the openings in the paver units. The bedding course aggregate may be used as the void filler. Smaller particle-sized stone chips (1/8” to 1/4”) are preferable, if available.

M. Wearing Course: The top surface of the paver surrounded by a chamfer.

1.05 SUBMITTALS

1. The dimensions of the manufacturer’s proposed mold assembly including pattern, dimensions of all cavities including radii, spacer bars and the top portion of the mold known as the head or shoe.

2. Installation plan, including grading methods, placement of structural section courses, compaction methods, and edge treatments.
3. Material samples of pavers showing the range of variation within the selected color(s) for approval by the Engineer, void filler aggregate, bedding course aggregate, base and sub-base course aggregate including a current sieve analysis of each showing conformance to the specifications.

1.06 QUALITY ASSURANCE

A. Quality Control Plan

The installer and manufacturer shall establish, provide and maintain a quality control plan. The quality control plan shall provide reasonable assurance that the materials and completed construction submitted for acceptance will conform to the contract requirements. Although guidelines are established and certain requirements are specified, they are minimal and the installer and manufacturer shall assume full responsibility for meeting all requirements.

The installer and manufacturer shall agree upon a method for measuring the clusters at the factory and in the field. That method shall be submitted in writing to the owner for approval.

The Quality Control Plan shall contain at a minimum, but not limited to, the following elements:

1. The manufacturer’s quality control procedures.

2. The manufacturer’s production records showing at a minimum the date of manufacture, a mix design designation, mold number, mold cycles, and sequential pallet numbers. Copies of such records shall be made available to the owner upon request.

3. The installer’s quality control procedures, including but not limited to, dimensional control methods, paving machine(s) head adjustment, typical daily work schedule to insure that all pavers placed on the bedding course on any given day are adjusted as required and vibrated, and installation of void filler completed at the end of that work day. (Exception: The installation of the void filler may not be installed for the first and second day due to start-up procedures.)

B. Sampling and Testing

The manufacturer shall employ an independent testing company, qualified to undertake tests in accordance with the applicable standards specified herein. Test results shall be provided to the installer and the owner, upon request.

Pavers shall be tested for density and dimensional variation, compressive strength (ASTM C140), density and absorption (ASTM C140) and abrasion resistance (ASTM C418).

The initial testing frequency shall be one set of tests for each 100,000 full-sized
pavers delivered to the site or at any time a change in the manufacturing process, mix design, cement, aggregate or other material occurs.

1. The following number of full-sized pavers shall be randomly sampled for each test: five (5) for dimensional variation; three (3) for density and absorption; three (3) for compressive strength; and three (3) for abrasion resistance.

2. If all pavers tested pass all requirements for a sequence of 400,000 pavers then the testing frequency may be relaxed to one set of tests for each 500,000 full-sized pavers. If any pavers fail any of the required tests then the testing frequency shall revert to the initial testing frequency.

3. When any of the individual test results fail to meet the specified requirements, the cube of pavers represented by that test sample shall be rejected. The manufacturer shall provide additional testing of paver samples taken from both before and after the rejected test sample to determine the sequence of the paver production run that should be rejected. In addition, the testing frequency shall revert to the initial testing frequency specified in Item B.1 for the balance of the project.

4. Additional testing, as described above, shall be carried out at no additional expense to the owner. The sequence of pavers found to be defective shall, if they have been delivered to the site, be removed from the site promptly at no expense to the owner or installer.

5. Pavers shall be sound and free from defects that would interfere with the proper placing of the pavers or impair the strength or performance of the construction.

C. Site Specific Work Plan (SSWP)

The installer and manufacturer shall each prepare a SSWP describing the overall plan to complete the work. This plan shall include at a minimum:

1. The quality control plan.

2. A description of the anticipated mold life, rate and effect of mold wear on pavers produced, individual mold runs, and a mold rotation plan.

3. Clear diagrams of the site showing the proposed starting point of the installation and the proposed direction of installation.

4. A method of measuring the clusters at the factory and in the field.

5. A description of the anticipated growth in cluster size due to mold wear and a plan for dealing with that growth or other dimensional variances.

6. A description of the personnel and equipment to be employed for each portion of the work including manufacture, installation and quality control.
7. The manufacturer’s proposed daily production rate and mold life for this project and supply data demonstrating experience on similar past projects. Installer shall state the proposed daily installation rate.

8. The installer’s intention to machine-lay or hand-lay the pavers and provide qualifying experience to date for the appropriate method of proposed installation for the ecological system.

D. Qualifications

Every manufacturer and installer shall demonstrate that they have supplied and/or installed Environmental pavers for projects of a similar nature. Qualifications of installers shall be submitted at the time of bid, without exception.

E. Paver Manufacturer’s Qualifications

1. The manufacturer shall demonstrate a minimum of five (5) years successful experience in the manufacture of interlocking concrete block pavers.

2. The manufacturer shall have sufficient production capacity and established quality control procedures to produce, transport, and deliver the required number of pavers with the quality specified, without causing a delay to the work.

3. The manufacturer shall have suitably experienced personnel and a management capability sufficient to produce the number of quality pavers as depicted on the contract Plans and as specified herein.

F. Paver Installer’s Qualifications

1. Installer shall provide installation history, including references in writing with contact information, demonstrating to the satisfaction of the owner their ability to perform the paver installation and related work indicated in the plans and specifications.

2. The installer shall have suitably experienced personnel and a management capability sufficient to execute the work shown on the contract Plans and specified herein.

3. The installer’s foreman shall demonstrate, including references, a minimum of 5 years experience in the installation of unit paver systems similar in size and nature to this project.

1.07 DELIVERY, STORAGE AND HANDLING

A. Concrete paving stones shall be delivered to the site, with or without pallets, in such a way that no damage occurs to the product during hauling and unloading.
B. All pavers shall be delivered to the site in approximately the chronological order in which they were manufactured. They shall be staged on the site as per the SSWP.

C. Each bundle of pavers shall be marked with a weather-proof tag identifying at a minimum the manufacturer, the date of manufacture, the mold number, the project name and phase for which the pavers were manufactured and the sequential bundle number.

PART 2 – PRODUCTS

2.01 ENVIRONMENTAL PAVERS

A. All interlocking paving stones shall comply with the quality specifications for solid concrete interlocking paving units as required per ASTM C936.

   2. Aggregates: Conform to ASTM C33 for normal weight concrete aggregate (no expanded shale or lightweight aggregate) except that grading requirements shall not necessarily apply.
   3. Water: Clean and free from any deleterious matter.
   4. Other Constituents: Air-entraining admixtures, integral water repellents and finely ground silica shall have a proven record of performance and shall conform to the relevant ASTM standards.
   5. Compressive Strength: At the time of delivery to the work site, the average compressive strength of the pavers shall not be less than 8,000 psi, with no individual unit less than 7,200 psi. Testing procedures shall be in accordance with ASTM C140.
   6. Absorption: The average absorption shall not be greater than five percent (5%) with no individual unit result greater than seven percent (7%) per ASTM C140.
   7. Resistance to Freezing and Thawing: The manufacturer shall satisfy the purchaser by laboratory testing that the paving units have adequate resistance to freezing and thawing per ASTM C67. The specimens shall have no breakage and not greater than 1% loss in dry weight of any individual unit when subjected to 50 cycles of freezing and thawing.
   8. Dimensional Tolerances: Pavers shall be prismatic in plan and formed with straight, uniform edges. The tolerance for the flat portions of the sides shall not exceed 1/32” as measured with a steel straight edge. “Slumped” pavers exceeding this tolerance will be rejected. The length, width and thickness of the paving stones shall meet the allowable tolerances specified in ASTM C936.


11. The measurement across a cluster from any cube shall not vary by more than the allowable tolerance of the individual paver units (1/16” per paver times the number of pavers across the cluster).

2.02 VISUAL INSPECTION

All units shall be sound and free of defects that would interfere with the proper placing of the unit or impair the strength or permanence of the construction. Minor cracks incidental to the usual methods of manufacture, or minor chipping resulting from customary methods of handling in shipment, delivery and installation, shall not be deemed grounds for rejection.

2.03 AGGREGATE MATERIALS

A. Bedding Course and Void Filler Aggregate

The bedding course and void filler aggregate shall be washed, crusher run, free of organics and soluble salts, or other contaminants likely to cause efflorescence. The grading requirement shall be in compliance with the following gradation chart.

<table>
<thead>
<tr>
<th>ASTM Sieve Size Percent Passing (by weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 inch 100 – 100</td>
</tr>
<tr>
<td>3/8 inch 94 – 100</td>
</tr>
<tr>
<td>¼ inch 39 – 94</td>
</tr>
<tr>
<td>No. 4 23 – 39</td>
</tr>
<tr>
<td>No. 8 8 – 23</td>
</tr>
<tr>
<td>No. 16 0 – 8</td>
</tr>
</tbody>
</table>

B. Base Course Aggregate

The base course aggregate shall consist of washed, crusher run, open-graded stone and meet the following gradation chart:

<table>
<thead>
<tr>
<th>ASTM Sieve Size Percent Passing (by weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2 inch 100 – 100</td>
</tr>
<tr>
<td>1 inch 90 – 100</td>
</tr>
<tr>
<td>3/4 inch 48 – 90</td>
</tr>
<tr>
<td>½ inch 27 – 48</td>
</tr>
<tr>
<td>¼ inch 12 – 27</td>
</tr>
<tr>
<td>No. 4 0 – 12</td>
</tr>
</tbody>
</table>

C. Sub-Base Course Aggregate

The sub-base course aggregate shall consist of washed, crusher run, open-graded stone and meet the following gradation chart:
ASTM Sieve Size Percent Passing (by weight)
4 inch 100 – 100
3 inch 80 – 100
2-1/2 inch 50 – 80
2 inch 20 – 50
1-1/2 inch 5 - 20
1 inch 0 – 5

PART 3 – EXECUTION

3.01 SUBGRADE

A. The Engineer shall verify that the subgrade has been shaped and compacted in conformance to the lines, grades and cross-sections shown on the plans, to provide for the construction of the Environmental Paving System pavement structure.

B. Site grades can be raised to the design subgrade elevation using clean native earth fill (free of deleterious material). This fill should be placed in lifts not exceeding six inches (6") and compacted to a minimum of ninety-five percent (95%) Standard Proctor density. The final subgrade profile should be uniformly compacted to a minimum of ninety-five percent (95%) Standard Proctor density and proof-rolled using a vibratory steel drum roller to delineate soft areas. Removing the unstable soil and replacing with clean, dry compacted earth fill shall be performed to repair these areas.

3.02 SUB-BASE COURSE

The thickness of the sub-base course layer will depend upon the subgrade soil conditions and the anticipated traffic loadings. It is recommended that a site assessment be carried out by an experienced qualified geotechnical engineer to determine the required thickness of the sub-base course.

The sub-base course shall consist of a minimum thickness of twelve inches (12") and be compacted using a vibratory smooth-drum roller. It shall be installed in lifts not to exceed six inches (6"). Upon completion of the sub-base course installation, the area shall be proof-rolled using a heavy rubber-tired vehicle (such as a loaded tandem truck) to identify any areas requiring additional compaction. The sub-base course shall be installed to the elevation and cross-section per the plan documents.

3.03 EDGE RESTRAINTS

All edge restraints shall be constructed as shown on the plans and in place prior to the installation of the base course, bedding course and pavers. Poured-in-place concrete curbs are recommended for the Bio-Aquifer Storm System.

3.04 BASE COURSE

The base course shall consist of a thickness of four inches (4"), placed in one lift, and be compacted using a vibratory smooth-drum roller until there is no visible movement of
aggregate under static rolling. The base course shall be installed to the elevation and cross-section per the plan documents.

3.05 BEDDING COURSE

A. The bedding course shall be spread loose in a uniform layer to give a depth after compaction of the paving units of two inches (2"), plus or minus 1/2". The contractor shall screed the bedding course using either a mechanical screed beam apparatus or by the use of screed guides and boards.

B. The screeded bedding aggregate shall not be subjected to any traffic by either mechanical equipment or pedestrian use prior to the installation of the paver units. The voids left after the removal of the screed rails shall be filled with loose aggregate as the paver bedding course proceeds.

3.06 ECOLOGICAL PAVERS

A. Lay pavers in the pattern as shown on the Plans. Lay pavers away from the existing laying face or edge restraint in such a manner as to ensure that the pattern remains square. Chalk lines shall be used upon the bedding course to maintain straight joint lines. Joint spacing between pavers shall be between 1/8" and 1/4": however, the joint width may need to be increased to 3/8" (if necessary) to maintain straight joint lines. Lines and grades shown on the plans shall be established and maintained during the installation of the wearing course.

B. Pavers shall be cut using a table-mounted masonry saw. Block splitting shall not be permitted. All cut faces shall be vertical. Dry cutting of the pavers shall be performed utilizing a dust collection system.

C. Once the pavers have been placed upon the bedding course and all cut pavers have been inserted to provide a full and complete surface, inspect the pavers for damaged units and remove and replace those units. Once all pattern lines have been straightened, the void filler shall then be placed into the paver openings to the top of the chamfer on the pavers and the surface swept broom clean.

D. The pavement surface shall be compacted to achieve consolidation of the bedding course and paving stones and brought to design levels and profiles by two passes of a suitable plate compactor. Compaction of the pavers shall be accomplished by the use of a vibratory plate compactor capable of a minimum of 4,500 pounds of compaction force. No compaction shall be permitted within three feet (3') of unrestrained edges of the pavement. After compaction, inspect the pavers for damaged units and remove and replace those units.

E. On completion of vibration after void filling, the surface tolerances shall be plus or minus 1/2" from finish levels. The pavers shall be flush to 1/2" above edge restraints. Additional void filler material shall be swept in the paver voids, as required, to within 1/2" from the bottom of the chamfer on the paving stones. Upon completion, the wearing course surface shall be swept clean of all excess materials. Remove from the site all surplus materials, equipment and debris resulting from these operations.
PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Environmental Paving will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

PAYMENT

A. Environmental Paving furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 05 12 23
STRUCTURAL STEEL

PART 1 - GENERAL

1.01 SUMMARY

A. Principal work in this Section:

1. Canopy including structural steel framing, beams embedded in concrete, columns, corrugated metal, gutter, column caps, cladding and trim complete with all shop and field connections.

2. Furnish anchor bolts, loose bearing plates, wedges, guying and bracing as required for this work.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 03 31 00 – Structural Concrete
2. Section 05 55 00 – Miscellaneous Metals
3. Section 09 90 00 – Painting and Coatings

1.02 REFERENCES

A. Comply with all applicable local, State and Federal Codes Standards, Specifications and Recommended Practices, latest edition thereof and in particular:

1. AWS D1.1: Structural Welding Code
2. AWS A2.4: Symbols for Welding and Non-Destructive Testing
4. AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings
5. AISC Code of Standard Practice for Steel Buildings and Bridges
7. ASTM A36: Specification for Structural Steel

1.03 SUBMITTALS
A. Submit the following in accordance with Section 01300, Submittals:

1. Shop drawings: Complete shop drawings and erection diagrams for this work. Make submittals as complete as possible on their first submittal.
   a) Should more than one submittal be required, later submittals shall clearly identify material added or revised subsequent to previous submittal.
   b) Indicate all shop and erection details, including cuts, copes, connections, holes, threaded fasteners, rivets and welds.

2. Current qualifications and certifications for welders used for this work.

3. Proposed welding sequence and welding qualifications to indicate the method of all welded connections. Identify all welds, both shop and field, in accordance with AWS A2.4.

B. Mill test reports for structural steel as specified.

1.04 QUALITY ASSURANCE

A. Fabricator's qualifications: All structural steel fabrication shall be performed in the shop of a fabricator with a current valid AISC Major Building Certificate.

B. Tests to be made and paid for by the Contractor:

1. Foreign-supplied steel or steel that cannot be identified: Make one tension and one bend test for each 50 tons or fractional part thereof, of each shape, heat or melt of stock used.

2. Tests: Take test specimens under the direction of an approved Testing Laboratory and machine to dimensions required by the applicable ASTM Specifications.

3. Develop test procedure to assure that steel conduit penetrations of canopy gutter for canopy lights has been welded watertight and that water does not leak through penetrations. Submit test procedure for approval. Conduct test at each penetration.

4. Fabricate and set up temporary silhouette of 10-foot section of canopy replicating canopy outline, height and location so clearance measurements can be verified with train positioned on Track 13 prior to Track 13 removal during construction. SCRRA will arrange for train to be positioned on Track 13 during test. Conduct clearance measurement between simulated canopy and rail car.

C. Tests will not be required for the following:

1. Mill order steel:
   a) Steel ordered from the mill, cut to lengths, identified by heat numbers,
and accompanied by mill test reports, may be used without testing provided it conforms to these Specifications.
b) In case of controversy, make tension and bend tests of the steel in accordance with applicable ASTM standards, either locally or at the mill, as specified hereafter for local stock.

2. Local stock steel: Local stock structural steel that can be identified by heat number and is accompanied by mill test reports may be used without testing provided it conforms to these Specifications.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Structural steel: ASTM A 36.
B. Steel tubing: ASTM A 500, Grade B.
C. Steel Pipe: ASTM A53, Grade B, Standard, Schedule 40

C. Fastening materials:

1. High-strength steel bolts, nuts and washers:
   a) Bolts: ASTM A 325, Slip Critical.
   b) Nuts: ASTM A563
   c) Washers: ASTM F436

D. Paint primer: Specified in 09900 Painting and Coatings.

2.02 FABRICATION

A. Fabrication shall be equal to that produced in modern structural steel shops, and shall conform to the applicable provisions contained in the AISC Code of Standard Practice, except where the drawings or these specifications differ they shall take precedence.

B. Wire-brush structural steel before its fabrication to remove all loose mill scale and heavy rust that would prohibit primer from satisfactorily bonding to it. Straighten structural steel members that do not conform to AISC tolerances by non-injurious methods.

C. Fabricate structural steel in accordance with the referenced AISC specifications and the following tolerances:

   1. After punching or working the component parts of a member, remove twists or bends before the parts are assembled.

   2. A variation of 1/32 inch will be permissible in the overall length of
members with both ends finished for contact bearing, as defined in the AISC Handbook.

3. Members without ends finished for contact bearing, which are to be framed to other steel parts of the structure, may have a variation from the detailed length not more than 1/16 inch for members 30 feet or shorter, and not more than 1/8 inch for members over 30 feet long.

4. Unless otherwise specified, structural members, whether of a single rolled shape or built-up, may vary from straightness within the tolerances allowed for wide flange shapes by ASTM A 6, except that the permissible tolerance for deviation from straightness of compression members shall be 1/1000 of the axial length between points which are to be laterally supported. Sharp kinks and/or bends will be cause for material rejection.

5. Any permissible deviation of depths of girders may result in abrupt changes in depth at splices. Take up all such differences at bolted joints, within the prescribed tolerances, with fill plates. The weld profile may be adjusted at welded joints to conform to the variation in depth provided the minimum cross section of required weld is furnished, and the slope of the weld surface meets AWS requirements.

D. Make all holes by punching or drilling; burned holes will not be acceptable.

E. Prepare and prime all structural steel as follows:

1. Prepare steel in accordance with SSPC-SP10, White Metal. Paint the same day with zinc-rich primer specified applied in accordance with the primer manufacturer’s printed instructions, including minimum dry film thickness.

2. Protect painted work until paint is thoroughly dry. Do not load material for shipment until shop coat is fully dry. Touch-up damaged primer immediately after delivery to site.

PART 3 - EXECUTION

3.01 INSPECTION

Inspect adjacent construction and make sure that all conditions detrimental to the proper and timely execution of this work have been corrected before proceeding.

3.02 ERECTION

A. Erect all structural steel in accordance with the Drawings and the referenced AISC Specifications, except provide washers on bolted connections using ASTM A 325 bolts regardless of the tightening method used. Use hardened washers with high strength bolts as required by ASTM A 325.

B. Field assembly:
1. Members and section shall be of sizes, weights, shapes and arrangements indicated, closely fitted and finished true to line and in precise position necessary to allow accurate erection and proper joining of parts in the field.

2. Drifting to enlarge unfair holes will not be allowed.

3. Rolled sections, except for minor details, shall not be heated without prior approval.

C. Contact:

1. Component parts of built-up members shall be well pinned and rigidly maintained in close contact using clamps or temporary bolting during welding.

2. Compression joints depending upon contact bearing shall have bearing surfaces accurately milled perpendicular to their axis, or as detailed.

D. Gas Cutting:

1. Use of a cutting torch is allowed where the metal being cut is not carrying stress during the operation, and provided stresses will not be transmitted through a flame-cut surface.

2. Make gas cuts smooth and regular in contour.

3. To determine the effective width of members to cut, deduct 1/8 inch from the width of the gas cut edges.

4. Make the radius of re-entrant gas cut fillets as large as practicable, but no less than 1 inch.

E. Punching, drilling and reaming:

1. Material may be punched 1/16 inch larger than the nominal diameter of the bolt, wherever the thickness of the metal is equal to or less than the diameter of the bolt plus 1/8 inch.

2. Where the metal is thicker than the diameter of the bolt plus 1/8 inch, the holes shall be drilled or sub-punched and reamed.

3. The die for sub-punched holes, and the drill for sub-drilled holes, shall be 1/16 inch larger than the nominal diameter of the bolt to be accommodated.

4. Finished holes shall be precisely located to insure passage of bolts through assembled materials without drifting.

5. Enlargement of holes necessary to receive bolts shall be done by
reaming.

6. Poor matching of holes will be sufficient cause for rejection.


G. Structural steel shall be erected by professional riggers and shall be carefully planned and laid out.

1. Erect this work plumb, square and true to line and level, and in precise positions as indicated.

2. Provide temporary bracing and guys wherever necessary to provide for loads and stresses to which the structure may be subjected, including those due to erection equipment and its operation, and leave in place as long as it may be necessary for safeguarding all parts of the work.

H. Temporary connections:

1. As erection progresses, this work shall be securely bolted up as necessary to maintain the steel in proper position while field bolting and welding is being done, and as necessary to take care of dead loads, wind, seismic, and erection stresses.

2. No field welding or high-strength bolting shall be done until this work has been properly aligned, plumbed and leveled.

I. Set column base plates in exact position, both as to alignment, level and elevation and support on steel wedges, or equivalent, until the grout thereunder has thoroughly set.

1. The center of each base shall be true to the column center within 1/16 inch.

2. Plates shall be exactly level on both axes.

J. Sequence: The erection of structural steel shall be carried out in proper sequence with the work of other trades, and shall be framed, bedded, and anchored to related work in strict accordance with the Drawings.

### 3.03 WELDING

A. Welding and welded joints: Detail and execute welds in accordance with the requirements of the American Welding Society Standards D1.1, unless otherwise modified by the referenced AISC Specifications or as otherwise noted on the Drawings.
1. In the event of conflicts, the Drawings shall take precedence.

2. Structural welding shall be done by one of the following processes:
   a) Shielded Metal Arch Welding Process
   b) Gas-Metal Arc and Flux-Cored Arc Welding
   c) Submerged Arc Welding

B. Operators qualifications: Thoroughly trained and experienced in arc welding of structures, capable of making uniformly reliable butt and fillet welds in flat, vertical and overhead positions, and producing neat, consistent work in actual operation.

1. Operators shall be certified in accordance with AWS requirements and shall have a valid local certification.

2. If welder's re-certification is required, it shall be the Contractor's responsibility to obtain it.

C. Storage and care of electrodes: Comply with the combined recommendations of the AWS and the electrode manufacturer's recommendations. When in conflict, comply with the more stringent requirements.

1. The coatings of low-hydrogen type electrodes shall be thoroughly dry when used. Electrodes of any classification that have been wet shall not be used under any conditions.

D. Preparation: Thoroughly clean surfaces to be welded of all paint, grease, scale and foreign matter.

1. Clean welds each time the electrode is changed and chip entire area of hand-guided and controlled flame cut edges before welds are deposited.

2. In general, surfaces made by automatic or mechanically guided and controlled equipment need not be ground or chipped before being welded.

E. Characteristics of welds: After being deposited, welds shall be wire brushed and shall exhibit uniform section, smoothness of welded metal, feather edges without undercuts of overlays and freedom from porosity and clinkers. Visual inspection at edges and ends of fillet welds shall indicate good fusion and penetration into base metal.

F. In assembling and during welding, hold components with sufficient clamps or other adequate means to keep parts straight and in close contact.

1. Take precautions when welding to minimize stress and distortion due to heat.

2. Do not weld in windy weather until adequate wind protection has been
provided and set up.

3. Welds or parts of welds found defective may be removed using the air-arc process or power chisels and replaced with satisfactory welds.

G. Tack welds shall be subject to the same quality requirements as the final welds except that:

1. Pre-heat is not mandatory for single pass welds which are re-melted and incorporated into continuous submerged arc welds.

2. Defects such as undercut, unfilled craters and porosity need not be removed before the final submerged arc welding.

3. Tack welds not incorporated into the final weld shall be removed. Tack welds incorporated into the final weld shall be cleaned thoroughly and multiple pass tack welds shall have cascaded ends.

H. Peening, in accordance with AWS Article 309, is allowed at the fabricator's option.

3.04 ANCHOR BOLTS

A. Furnish all anchor bolts and connection material to be embedded in the concrete when and as required to maintain job progress.

B. Provide the necessary drawings and templates for the setting of such anchor bolts and connection material in the concrete forms.

C. Perform setting anchor bolts in hardened concrete, necessitated through error or oversight, and in existing concrete work, under the Engineer's direction in suitable drilled holes solidly grouted in place, or embedded in an approved structural epoxy.

3.05 GROUTING BEARING PLATES

A. Be responsible for maintaining bearing plates in proper location and in proper level while they are being grouted. Note that all grouting is specified to be performed by Section 03 31 00, Structural Concrete.

3.06 TOUCH-UP

A. Clean abraded areas of shop primer to bright metal, and touch-up with same primer used for shop priming. Extend touch-up at least 2 inches onto sound, undamaged primer.

3.07 FIELD QUALITY CONTROL

A. The registered Deputy Building Inspector employed by SCRRRA will inspect field
welding and high-strength bolting of structural steel framing in accordance with Building Code Requirements. Coordinate with the registered Deputy Building Inspector and afford him full and safe access to the work as required for the performance of his duties.

B. The registered Deputy Building Inspector will be required to certify in writing upon completion of this work that all welding and high-strength bolting has been performed in accordance with the Drawings, Specifications, and Building Code Requirements.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Structural Steel will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Embedded Beams at Double Column/Staircase Structure, Canopy Gutter, Gutter Waterproofing, Gutter Trim, Corrugated Metal Deck and End Closure, Galvanized Steel Trim at End Closure, Columns, Column Cladding, Fabricated Column Caps, Column Steel Trim, Concrete Canopy Column Foundations at Single Columns will be included in this Section and are considered incidental to work under this Section and will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer.

4.02 PAYMENT

A. Structural Steel furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.
PART 1 - GENERAL

1.01 SUMMARY

A. This Section addresses the products, materials and work for the installation of metal hand railing, stainless steel hand railing, Right-of-Way Security Gates, and pedestrian barricade as shown on the Contract Plans and as specified in these Specifications, and as directed by the Engineer.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 05 12 23 - Structural Steel
2. Section 09 90 00 - Painting and Coating

A.02 REFERENCES

A. AWS D1.1: Structural Welding Code-Steel
C. CALTRANS: State of California Department of Transportation Standard Specifications 2010 Section 83
D. American Iron and Steel Institute: Type 302 and 304 Steel
E. American National Standards Institute (ANSI) ANSI A12.1 Safety Requirements for Floor and Wall Openings, Railings and Toeboards
F. American Society for Testing and Materials (ASTM)
   1. A123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
   2. D4956 Standard Specifications for Retroreflective Sheeting for Traffic Control
G. State of California, Department of Industrial Relations, Division of Occupational Safety and Health (CAL/OSHA): As applicable to railing
H. Use finishes for stainless steel complying with “Metal Finishes Manual” by NAAMM.
I. The sheet Work, except as otherwise indicated or specified, shall comply with “Architectural Sheet Metal Specifications” and “Architectural Sheet Metal Manual” by SMACNA.
J. SCRRRA Engineering Standards ES4005, Pedestrian Barricade and Metal Hand Railing Details. Use sleeve post detail from Pedestrian Barricade Detail for Removable Metal Hand Railing.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00, Submittal Procedures:

1. Shop Drawings: In accordance with the Contract Plans, showing the details and dimensions of all removable metal hand railing and metal hand railings, sleeve post, and posts and fences. Note dimensions which have been field verified.

2. Welding procedures and welder qualifications and welder registration as required by the American Welding Society.

3. Manufacturer’s product data for non-shrink, non-ferrous cement grout.

B. Shop Drawings showing layout, locations, Sections, elevations, details, dimensions, finishes and installation details.

C. Certified test reports, as required, for materials specified in Part 2 - Products.

D. Submit Shop Drawings for the fabrication and erection of stainless steel assemblies and proprietary products which are not otherwise completely shown by manufacturer’s data sheets. Include plans and elevations at not less than one-inch to one-foot scale, and include details of sections and connections at not less than three inches to one foot scale. Show anchorage and accessory items, and finishes.

1.04 QUALITY ASSURANCE

A. All uncoated spots or damaged coating shall be repaired by hot-dip process. Small areas as determined by the Engineer may be repaired by recoating them with “Galvicon” or “Gavalloy” or approved equivalent.

B. Perform welding in accordance with AWS D1.1.

C. Set handrails and posts true to location, alignment and grade as indicated in the Contract Plans. The railings shall present a smooth, uniform appearance in their final positions.

D. Painting of Rails: In accordance with Section 09 90 00, Painting and Coating, unless otherwise directed by the Engineer.
PART 2 - PRODUCTS

2.01 STEEL PIPES

Pipe for post, sleeve post, rail and pickets shall be seamless steel pipe, conforming to ASTM A53, Type S, Grade A.

2.02 GENERAL

A. Metal Surfaces – For the fabrication of Work which will be exposed to view, use materials which are smooth and free of surface blemishes. Do not use materials which have stains and discolorations, including welds which do not match the materials in color and grain characteristics.

B. Surface Flatness and Edges – For exposed Work provide materials which have been cold-rolled, cold-finished, cold-drawn, extruded, stretcher leveled, machine cut or otherwise produced to the highest commercial standard for flatness with edges and corners sharp and true to angle or curvature as required.

2.03 STAINLESS STEEL

Use AISI Type 302 or Type 304 (at fabricator’s option), except as otherwise indicated. Comply with the following general standards, with specific type, alloy, heat treatment and finish as required to produce the specific Work. Finish products to a No. 4 directional satin unless otherwise shown or specified. Protect with adhesive paper covering.

A. Sheet – ASTM A167, ASTM A480, and AISI Type 302 or 304
B. Plate – ASTM A167
C. Bar Stock – ASTM A276
D. Tubing – ASTM A269
E. Castings – ASTM A296, iron-chromium, nickel
F. Extruded Shapes – Manufacturer’s standards

2.04 FASTENERS AND ANCHORAGE MATERIALS

A. Welding Electrodes and Filler Metal – Provide the alloy and type required for strength, workability, compatibility, and color match after grinding smooth and finishing the fabricated product.

B. Fasteners – Some basic metal or alloy as the metal fastened, and finished to match in color and texture. Comply with FS FF-S-92 for machine screws. Provide the type of fasteners indicated and provide Phillips flat-head screws for exposed fasteners.

C. Anchors and Inserts – Either furnish inserts to be set in concrete and masonry Work, or provide other anchoring devices as required for the installation of
stainless steel Work. Furnish stainless steel or epoxy-coated inserts (See Concrete and Masonry Sections for installation); provide toothed stainless steel expansion bolt devices for drilled-in-place anchors.

2.05 FABRICATION - GENERAL

A. Fabricate from the thicknesses, sizes and shapes indicated, or if not indicated, as required to produce Work of adequate strength and durability, without objectionable deflections or “oil canning.”

B. Form exposed Work true to line and level, with flush surfaces and accurate angles. Ease exposed edges to a 1/32-inch radius, unless otherwise indicated. Miter exposed corner joints and machine fit to a hairline joint.

C. Weld corners and seams continuously, grind smooth and flush on exposed surfaces. For exposed metal finishes, use metals which will blend and match with sheet metals being joined; discolorations or stains will not be acceptable for exposed portions of natural finish metals. Comply with recommendations of AWS for welding.

D. Provide brackets, plates and straps with each assembly, as may be required for proper support and anchorage to other Work.

E. Cut, reinforce, drill and tap Work as may be required to receive finish hardware and similar items of Work.

F. Preassemble Work at shop to the greatest extent possible, so as to minimize mechanical joints, splicing and assembly of units at the site.

2.06 RAILINGS AND HANDRAILS

A. Comply with ANSI A12.1 and CAL OSHA requirements for railings around floor openings and exposed edges of floors, stairs, ramps, and similar locations. Install railings and supports able to withstand a horizontal force of 150 pounds per linear foot and vertical force of 100 pounds per linear foot at the top or 50 pounds per foot along the top rail, whichever is greater.

B. In tubular members, where mechanical joints are necessary, use bar stock inserts with flat-head screws located on the least visible surfaces. Where bends are shown, form members to a smooth, uniform radius without distortion of the cross-sectional shape.

C. Miter and cope members at corners and intersections. Bevel, weld and grind smooth, without fillets, to form smooth transitions and maintain sharp lines.

D. Post-mounted railings – Use base plates as indicated.

E. Provide dissimilar metals isolation pads where required.

G. Comply with ASTM D4956 Standard Specifications for Retroreflective Sheeting for Traffic Control for yellow sheeting on railing.
PART 3 - EXECUTION

3.01 FABRICATION

Fabrication of metal hand railings and fencing shall be in accordance with SSPWC 2009 Sub-Section 304-2.1.2.

3.02 INSTALLATION

A. Set stainless steel Work accurately as measured from established building lines and levels, plumb and in true alignment with previously completed Work. Temporarily brace or anchor securely in formwork where Work is to be built into concrete, masonry or similar construction.

B. Securely anchor in place using concealed anchorage wherever possible.

C. Accurately fit mechanical joints together to form tight joints and uniform reveals and shapes for joint fillers and sealants. Restore finishes that have been damaged by shipment and installation.

D. Do not cut or abrade finishes which cannot be completely restored in the field. Return units with such finishes to the shop for required alterations, followed by complete refinishing.

E. Remove protective coverings when there is no longer danger of damage to the stainless steel Work from other Work yet to be performed. Restore protective coverings which have been removed or damaged during shipment or installation of the Work, if other Work is yet to be performed.

F. Form bends and simple and compound curves in tubing by bending members in jigs to produce uniform curvature, maintain profile of member throughout bend without buckling, twisting or otherwise deforming exposed surfaces of handrail and railing components.

G. Railing splices performed in field - Use epoxy structural adhesive or other equivalent means standard with railing manufacturer. Field welding - Not permitted. Railing splices - Butted to flush hairline joint and reinforced using manufacturer's standard concealed fittings with concealed fasteners. Lay out Work to position splices in inconspicuous locations.

H. Provide weep holes or other means for evacuation of entrapped water in hollow Sections of railing members.

I. Provide wall returns at ends of wall mounted handrails, except where otherwise indicated.

J. Close exposed ends of handrail and tubular rail members by use of plates welded and ground smooth.
K. Furnish inserts and other anchorage devices for connecting handrails and railings to concrete or masonry Work. Fabricate and space anchorage devices as indicated and as required providing adequate support. Coordinate anchorage devices with supporting structure.

L. The galvanized bolt thread for removable metal hand railing shall not be deformed after installation.

M. Removal of Existing Pavement - Remove the existing pavement by core drilling pavement to the full depth of the existing pavement thickness in clean, straight lines with neat edges. Haul all removed material off the work site daily and dispose of in a legal manner.

N. Excavation - Remove material to the width and depth required for construction of the pedestrian gate foundation. Take care not to disturb the bottom of the excavation before the concrete for the foundation is placed. Replace excavation below the required grade or more than the required width with the same class of concrete specified for the foundation, at no additional cost to the Authority.

O. Foundation and Installation of Gate Posts

1. Inspection Required Before Placing Concrete - Do not deposit concrete until the excavation, placing of the reinforcing steel, and placing of the gate posts has been inspected and approved. Provide at least one working day’s advance notice that the excavation is ready for inspection and the procedure is approved for installation of the gates.

2. Concrete - Class 520-C-3250 - Portland Cement Concrete shall be used for the foundation.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Railings, Hand Railing, and ROW Security Gates will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Pedestrian Barricade will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.
4.02 PAYMENT

A. Railings, Hand Railing, and ROW security Gates will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Pedestrian Barricade will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

C. Full compensation for furnishing and placing concrete footings, and connecting new railing to structures and existing cross railing shall be considered as included as listed on the Schedule of Quantities and Prices.

END OF SECTION
SECTION 05 52 10

PEDESTRIAN SWING GATES

PART 1 – GENERAL

1.01 SUMMARY

A. The work involves furnishing and installing self-closing pedestrian swing gates at the highway-rail and pedestrian-rail grade crossings on the Metrolink commuter rail system. Install gates on the locations shown on the Contract Plans.

B. Related Specification Sections include but are not necessarily limited to:

   1. Section 03 21 00 – Reinforcing Steel
   2. Section 03 31 00 Structural Concrete
   3. Section 09 90 00 - Painting and Coating

1.02 REFERENCES

A. SCRRRA Engineering Standards ES4002, Pedestrian Swing Gate Details.


PART 2 - PRODUCTS

2.01 SWING GATES FABRICATION

Fabricate the swing gates as indicated in the Contract Plans.

A. Submittals Requirements - Submit Shop Drawings indicating bill of materials, and details for fabrication and assembly for approval prior to commencing fabrication.

B. Demonstration of Swing Gate Operation

   1. Shop-assemble and test the swing gates for proper operation before installation at the worksite.

   2. Assemble one gate section to demonstrate its opening and closing operation, for approval, at the shop. Provide at least five (5) working days advance notice for the gate operation demonstration before any further gate fabrication work is done and before any installation work commences. If the gate operation demonstration is not approved, make modifications to the gate section and repeat the gate operation.
demonstration until approval is obtained.

C. Gate Material - Fabricate the gate from steel tubing conforming to ASTM A500, Grade B. Provide gate post caps fabricated from flat steel plate conforming to ASTM A6, continuously welded in place, welded watertight, and made flush and smooth with the gate posts.

D. Gate Hinges and Stop Plates

1. Fabricate the gate hinges and stop plates, except for the hinge sleeves, from steel material conforming to ASTM A36. Neatly miter and cope all intersections, weld continuously in place as indicated in the Contract Plans, and finish so that adjoining surfaces are flush and smooth.

2. Fabricate the gravity gate hinge top and bottom sleeves, as indicated in the Contract Plans, from hardened steel conforming to ASTM A4140 heat treated and borided. Precision machine to the nearest 0.001 of an inch. Polish the rotating curved contract surfaces of the top and bottom hinge sleeves.

E. Galvanizing - After fabrication, hot-dip galvanize the swing gates including the gate posts, gate frames, hinges (except the rotating curved contact surfaces of the top and bottom hinge sleeves), and stop plates, in accordance with ASTM A123 or ASTM A153. Provide minimum weight of the galvanizing coating of 2.0 ounces per square feet. Repair and re-coat any coating which has been shop or field cut, burned by welding, or otherwise damaged so that the base metal is exposed.

F. Gate Signs - Provide signs as indicated in the Contract Plans. Use reflective sheeting on 0.080-inch aluminum sign panel. Provide anti-graffiti coating.

G. Welding - Welding shall conform to the requirements of American Welding Society AWS D1.1, Structural Welding Code.

PART 3 - EXECUTION

3.01 SWING GATE INSTALLATION

A. Existing Underground Utilities and Facilities - Identify existing underground utilities, conduits, foundations, and other facilities which could be affected by the construction, including railroad signal conduits. Hand dig to uncover these underground facilities and implement the necessary measures to protect these facilities during construction.

B. Removal of Existing Pavement - Remove the existing pavement by core drilling pavement to the full depth of the existing pavement thickness in clean, straight lines with neat edges. Haul all removed material off the work site daily and dispose of in a legal manner.

C. Excavation - Remove material to the width and depth required for construction of the pedestrian gate foundation. Take care not to disturb the bottom of the excavation before the concrete for the foundation is placed. Replace excavation below the required grade or more than the required width with the same class of
concrete specified for the foundation, at no additional cost to the Authority.

D. Foundation and Installation of Gate Posts

1. Inspection Required Before Placing Concrete - Do not deposit concrete until the excavation, placing of the reinforcing steel, and placing of the gate posts has been inspected and approved. Provide at least one working day's advance notice that the excavation is ready for inspection and the procedure is approved for installation of the gates.

2. Concrete - Class 560-C-3250 - Portland Cement Concrete shall be used for the foundation.

E. Swing Gates Installation - Install swing gates on gate posts. Adjust gate operation, as necessary, to ensure proper operation.

F. Replacement of Portland Cement Concrete Pavement - Use four inches of Class 520-A-2500 Portland Cement Concrete pavement, placed over at least four inches of crushed aggregate base material compacted to 95 percent relative compaction, to replace removed Portland cement concrete pavement. Install paving tiles which match the size and color of the existing paving tiles on the concrete. Submit a sample paving tile for approval at least two (2) weeks before installation of paving tiles commences. Carefully cut paving tiles in clean, straight lines with neatly sawed edges to match existing tiles.

G. Pedestrian Traffic Control During Construction - Maintain pedestrian traffic flow at all times during construction.

H. Submittal Requirements - Submit a pedestrian traffic control plan for approval before commencing construction work at the pedestrian crossing. Describe in detail how pedestrian traffic will be maintained during construction, including temporary pedestrian crossing requirements, measures to be implemented for pedestrian safety in the vicinity of open excavation and other work areas during construction.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Pedestrian Swing Gates will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Pedestrian Swing Gates furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the
Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Full compensation for furnishing and placing concrete footings, and connecting to structures and existing railing shall be considered as included as listed on the Schedule of Quantities and Prices.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:
   1. Heavy duty metal bar gratings
   2. Metal frames and supports for gratings
   3. Accessories required for a complete installation

B. Related Specification Sections include but are not limited to:
   1. Section 03 21 00, Reinforcing Steel

1.02 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide gratings capable of withstanding imposed structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections:

   1. Sidewalks, Vehicular Driveways, Other Exterior At-Grade Locations: Capable of withstanding HS20 traffic loads. At tracks, must support 8000 axle loads.

   2. Personnel Platforms and Walkways: Capable of withstanding a uniform live load of 250 lbf/sq. ft., plus dead load or a concentrated load of 3000 lbf, whichever produces the greater stress.

   3. Greater Loads: As required to support equipment or where indicated.

1.03 SUBMITTALS

A. Make submittals in accordance with Section 01 33 00, Submittal Procedures.

B. Product Data: Manufacturer’s technical data including:

   1. Clips and anchorage devices for gratings
   2. Paint products

C. Shop Drawings: Show fabrication and installation details for gratings. Include plans, elevations, sections, details, and attachments to other work. Provide templates for anchors and bolts specified for installation under other Sections.
1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation.

D. Welding Certificates: Copies of certificates for welding procedures and personnel.

1.04 QUALITY ASSURANCE

A. Metal Bar Grating Standards: Comply with applicable requirements of the following:

1. NAAMM MBG 532, Heavy-Duty Metal Bar Grating Manual

B. Professional Engineer Qualifications: A Professional Engineer, legally qualified to practice in the State of California, and experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of gratings that are similar to those indicated in material, design, and extent.

C. Fabricator Qualifications: A firm experienced in producing gratings similar to those indicated for this Project and with a record of successful in service performance, as well as sufficient production capacity to produce required units.

D. Welding: Qualify procedures and personnel according to AWS D1.1, Structural Welding Code-Steel and AWS D1.3, Structural Welding Code- Sheet Steel.

1.05 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of other construction contiguous with gratings by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.06 COORDINATION

A. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to site in time for installation.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Obtain steel grating and products from a manufacturer specializing in fabrication of the types of units required, which has tested its units for load bearing strength and deflection, and has currently published load tables based on recognized testing procedures.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equivalent approved as a comparable product:
1. Alabama Metal Industries Corp.
2. All American Grating, Inc.
3. Harris Steel Ltd.; Fisher & Ludlow Div.
4. Ohio Gratings, Inc.

C. Steel Plates, Shapes, and Bars: ASTM A36 (A36M)
D. Wire Rod for Grating Crossbars: ASTM A510 (A510M)
E. Uncoated Steel Sheet: ASTM A1011 (A1011M), structural steel, Grade 30 (Grade 205)
F. Galvanized Steel Sheet: ASTM A653 (A653M), structural quality, Grade 33 (Grade 230), with G90 (Z275) coating

2.02 FASTENERS

A. Provide Type 304 or 316 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

B. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E488, conducted by a qualified independent testing agency.

2.03 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy to be welded.


C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

2.04 FABRICATION

A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.
C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and sharp or rough areas on exposed surfaces.


D. Ease exposed edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated.

E. Form from materials of size, thicknesses, and shapes indicated, but not less than that needed to support indicated loads.

F. Fit exposed connections accurately together to form hairline joints.

G. Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately. See Section 05 55 00, Miscellaneous Metals.

H. Unless otherwise specified, gratings shall be welded to their supports as indicated. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

I. Traffic Surface: Plain.

J. Shop Finish: Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. (550 g/sq. m) of coated surface.

### 2.05 METAL BAR GRATINGS

A. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.

1. Heavy Duty Grating: Minimum four weld lugs for each heavy-duty grating section, with each lug shop welded to two bearing bars.

2. Furnish threaded bolts with nuts and washers for securing grating to supports.
3. Furnish galvanized malleable iron flange clamp with galvanized bolt for securing grating to supports. Furnish as a system designed to be installed from above grating by one person.

B. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.  
   1. Edge band openings in grating that interrupt four or more bearing bars with bars of the same size and material as bearing bars.

C. Do not notch bearing bars at supports to maintain elevation.

2.06 GRATING FRAMES AND SUPPORTS

A. Steel Frames and Supports: Fabricate from structural steel shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

B. Equip units with integrally welded anchors for casting into concrete or building into masonry.  
   1. Unless otherwise indicated, space anchors 24 inches (600 mm) o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long (32 mm by 6 mm by 200 mm).

C. Galvanize exterior and interior frames and supports.

2.07 FINISHES

A. Comply with NAAMM's Metal Finishes Manual for Architectural and Metal Products for recommendations for applying and designating finishes.

B. Finish gratings, frames, and supports after assembly.

C. Galvanizing: Apply zinc coating by the hot dip process complying with ASTM A123.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free from rack.
C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

3.02 INSTALLING METAL BAR GRATINGS

A. Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

C. Attach non-removable units to supporting members by welding where both materials are the same; otherwise, fasten by bolting as indicated above.

3.03 CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780.

PART 4 - MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.
SECTION 05 55 00
MISCELLANEOUS METALS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:
   1. Pull irons, inserts, channels and other items required by utility companies.
   2. Miscellaneous metal angles, plates, bars, rods, studs, etc. shown or required to complete the work.
   3. Coated Woven wire mesh (metal mesh)
   4. Shop-primed finish for all miscellaneous metal fabrications not receiving galvanized finish, except for gratings.
   5. Painted steel ship’s ladders and brackets

B. Coordinate work of this Section with all other Sections of this Specification and in particular:
   1. Section 03 21 00 - Structural Steel.

1.02 REFERENCES

A. Comply with all applicable local, State and Federal codes, specifications, standards and recommend practices, and in particular:
   1. AISC - American Institute of Steel Construction: “Design, Fabrication and Erection of Structural Steel for Buildings”.
   2. AISI - American Institute of Steel and Iron: “Specifications for the Design of Cold-Formed Steel Structural Members”.


C. ASTM

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00, Submittal Procedures
   1. Shop Drawings: Large scale, clearly indicating all methods of fabrication and assembly, applicable field measurements, dimensions, weights, materials, finishes and all other pertinent data.
1.04 **QUALITY ASSURANCE**

A. All steel fabrications shall be done by a licensed fabrication shop with a minimum of five (5) years experience in this type of work.

**PART 2 - PRODUCTS**

2.01 **MATERIALS**

A. Steel plates, bars and studs (including ship’s ladder):
   1. Rolled shapes and plates: ASTM A36
   2. Bars: ASTM A36
   3. Studs: ASTM A1044 / A1044M

B. Steel tubing:
   1. Cold-drawn tubing: ASTM A512, sunk drawn, butt welded, cold-finished and stress relieved
   2. Hot-formed tubing: ASTM A501, butt welded, cold-finished and stress relieved

C. Iron castings:
   1. Gray iron castings: ASTM A48, Class 30B
   2. Malleable iron castings: ASTM A47

D. Polyvinyl chloride coated and zinc coated woven steel wire with 11 GA core, 8GA finish with custom color to be selected by Authority.
   1. ASTM F668 2A
   2. AASHTO M181
   3. Type IV Class

E. Anchors: Expansion anchors by Hilti, Rawlplug Company, Inc., or equal. Provide anchors of the types shown and required for the various conditions of use, installed in accordance with manufacturer's printed instructions.

F. Fasteners: Galvanized steel fasteners of the type, grade and class required for the installation of miscellaneous metal items.

G. Welding electrodes: Low hydrogen type conforming to AWS D1.4, E70 XX Series.

H. Shop primer: Fabricator's standard thermosetting or air-drying shop primer compatible with alkyd enamel finish paint specified in Section 09 90 00, Painting
and Coatings, applied in a uniform dry film not less than 1-1/2 mils thick.

2.02 FABRICATION

A. Metal Work Exposed to View - Use materials that are smooth and free of surface blemishes including pitting, seam marks, and roller and grinding marks, before cleaning, treating and applying finishes including zinc coatings.

B. Use materials of size and thicknesses indicated or, if not indicated, of required size and thickness to produce adequate strength and durability in finished product for intended use. Work to dimensions shown on reviewed and accepted Shop Drawings, using proven details of fabrication and support. Use types of materials indicated for various components of Work.

C. Form exposed Work true to line and level, with accurate angles and surfaces and straight, sharp edges. Ease exposed edges to a radius of approximately 1/32 inch unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing Work.

D. Verify dimensions by accurate field measurement before fabrication where Work of this Section adjoins preceding Work. Do not delay job progress; allow for trimming and fitting metalwork where taking field measurements before fabrication might delay the Work. Note on Shop Drawings dimensions verified by field measurement.

E. Form exposed connections with hairline joints flush and smooth, using concealed fasteners wherever possible. Exposed fasteners - f type indicated or, if not indicated, use Phillips flat-head countersunk screws or bolts.

F. Pre-drill bolt and screw holes as indicated and required for attachment of metalwork and adjacent materials.

G. Furnish inserts and anchoring devices to be set in concrete for installation of metalwork. Coordinate delivery with other Work to avoid delay.

H. Provide anchorage of type indicated. Fabricate and space anchoring devices as indicated and required to provide adequate support for intended use of Work.

I. Cut, reinforce, drill and tap metalwork as required to receive finish hardware and similar items of Work.

J. Use hot-rolled steel bar for Work fabricated from bar stock, unless Work is indicated to be fabricated from cold-finished or cold-rolled stock.

K. Pre-assemble Work in shop to greatest extent practicable; minimize field splicing and assembly of units at Worksite. Disassemble units to extent necessary to comply with shipping and handling limitations. Clearly mark units for reassembly and proper installation.

L. Where indicated as galvanized, complete shop fabrication before applying coating. Remove mill scale and rust, clean and pickle units as required for
coating. Apply hot-dip zinc coating, two ounces per square foot, in accordance with ASTM A123.

M. Fabricate complete with anchors, inserts and hardware.

N. Form and finish to shape and size with sharp angles and lines.

O. Countersink metalwork to receive required hardware and to provide bevels and clearances.

P. Weld on hardware mounting plates. Drill or punch holes for bolts and screws. Conceal fastenings wherever possible.

Q. Grind exposed edges smooth. Construct joints exposed to weather to exclude water and provide weep holes indicated.

R. Brackets, lugs and similar accessories required for installation - Include as part of fabrication.

S. Welding:

1. Weld all shop and field connections continuously in accordance with the referenced AWS specifications, unless bolted connections are specifically shown.

2. Grind all exposed welds flush and smooth with parent metal surfaces.

3. All welders shall be qualified in accordance with AWS requirements.

T. Form bent metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.

U. Bend pipe without collapsing or deforming the walls, to produce a smooth, uniform curved sections and maintain uniform sectional shape.

V. Fabricate items in the largest sections practical to minimize field jointing.

2.03 FINISHING

A. Galvanizing: Galvanize plates and angles, after fabrication, to obtain a minimum zinc coating of 1.25 ounces per square foot when tested in accordance with ASTM A123.

B. Shop priming: After galvanizing shop prime steel surfaces as follows.

1. Clean steel surfaces of all oil and other foreign substances that would interfere with paint bond in accordance with applicable SSPWC specifications.

2. Apply pretreatment to cleaned steel surfaces using solution recommended
3. Apply the shop primer within the time limits recommended for the pretreatment system used. The shop primer shall be a smooth and even coating with a dry film thickness of not less than 1-1/2 mils.

PART 3 - EXECUTION

3.01 INSPECTION

A. Inspect adjacent construction and make sure that all conditions detrimental to the timely and proper execution of this work have been corrected before proceeding.

3.02 INSTALLATION

A. Perform all cutting, drilling and fitting required for the installation of this work. Install all items accurately in their proper location, alignment and elevations, plumb and level, free of rack as measured from established lines and levels. Provide temporary bracing or anchors for items that are to be built into concrete, masonry or similar construction.

B. Fit exposed connections accurately to form tight hairline joints. Weld connections that are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind exposed joints smooth and flush with parent metal and touch-up shop paint coat.

C. Comply with AWS recommendations for welding procedures, appearance and quality of welds made, and methods used to correct faulty welds.

3.03 TOUCH-UP OF DAMAGED SHOP PRIMER

A. Clean the damaged shop primer, sand smooth, re-clean and spot-prime with the same paint used for shop priming.

3.04 PROTECTION AND REPLACEMENT

A. Protect fabrications from construction damage.

B. Promptly replace work damaged beyond satisfactory field repair before its acceptance, with new materials at no additional cost to Authority.

PART 4 – MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 09 61 50
DETECTABLE WARNING PANELS

PART 1 - GENERAL

1.01 SUMMARY
   A. This Section includes specifications for Detectable Warning Panels for pedestrian
grade crossings, curb ramps, and platforms in Metrolink stations.

1.02 REFERENCES
   A. ASTM International:
      1. B117 Practice for Operating Salt Spray (Fog) Apparatus
         Tile by the Taber Abraser
      3. C1028 Test Method for Determining the Static Coefficient of Friction of
         Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer
         Pull-Meter Method
      4. D570 Test Method for Water Absorption of Plastics
      5. D638 Test Method for Tensile Properties of Plastics
      7. D790 Test Methods for Flexural Properties of Unreinforced and
         Reinforced Plastics and Electrical Insulating Materials
      8. D1308 Test Method for Effect of Household Chemicals on Clear and
         Pigmented Organic Finishes
         by Means of a Striker Impacted by a Falling Weight (Gardner Impact)
     10. G155 Practice for Operating Xenon Arc Light Apparatus for Exposure of
         Non-Metallic Materials
   B. Americans with Disabilities Act (ADA) Standards issued by U.S. Department of
      Transportation
   C. California Building Code

1.03 SUBMITTALS
   A. Shop Drawings
1. Submit Shop Drawings showing fabrication details; panel surface profile; fastener locations; plans of panel placement including joints, and material to be used as well as outlining installation materials and procedure. Include procedures for containment and disposal of milling and saw cutting waste water.

2. The Shop Drawings do not need to feature a full dimensional layout of the platform edges.

B. Product Data
1. Submit manufacturer's literature describing products and installation procedures. Include product data for adhesives and sealants.

C. Samples
1. Submit the following samples:
   a. Samples of panels measuring at least 12 inches x 12 inches. Panel sample shall include longitudinal edge with integral flange and transverse ship-lap edges.
   b. Samples of panels and sealant for verification of color match.

D. Samples for Verification Purposes
1. Submit panels of the kind proposed for use.

E. Maintenance Instructions
1. Submit manufacturer's specified maintenance practices for each type of panel and accessory as required.

F. Quality Assurance Submittals
1. Material Test Reports: Submit test reports from qualified independent testing laboratory indicating that materials proposed for use are in compliance with requirements and meet the properties indicated in this Section. Tests which indicate performance for the panels shall have been performed within three (3) years of the Invitation to Bid.

2. Submit list of projects in California that successfully demonstrate the proposed products’ durability and weatherability.

1.04 QUALITY ASSURANCE

A. Panels and accessories, including panel adhesive, fasteners, and sealants, shall be from a single source. Products shall have been in successful service for a period of five (5) years.

B. Installer’s Qualifications
1. Engage an experienced Installer certified in writing by panel manufacturer as qualified for installation, who has successfully completed panel installations similar in material, design, and extent to that indicated for Project. Only persons who are thoroughly trained and experience in the installation of the panels shall perform the work.

1.05 DELIVERY, STORAGE AND HANDLING

A. Panel type shall be identified by part number on packages.

1.06 SITE CONDITIONS

A. Environmental Conditions and Protection

1. Conduct field operations only when environmental conditions fall within those recommended by manufacturers of the products.

1.07 WARRANTY

A. Panels shall be covered by a written warranty for a period of five (5) years from date of final completion. The warranty includes defective work, breakage, deformation, delamination, fading and chalking of finishes, and loosening of panels. Warranty shall include furnishing new materials, removal of existing panels, and installation of new panels.

1.08 SPARES

A. Furnish a minimum of five (5) percent additional panels of the total amount installed of each panel and corresponding fasteners. Deliver spares to location (within 50 mile radius of work site) designated by the Engineer. Furnish spare materials from same manufactured lot as materials installed and enclose in protective packaging with appropriate identification.

PART 2 - PRODUCTS

2.01 PANELS

A. Subject to conformance with the requirements of this Section, use products fabricated by the following manufacturers or approved equal:

1. Armor-Tile by Engineered Plastics, Inc. of Williamsville, NY
2. ADA Solutions, Inc. of North Billerica, MA
3. Access Products of Buffalo, NY

B. Panels shall be manufactured from a fiber reinforced polymer composite.

C. Panel color shall be Federal Yellow conforming to Federal Color No. 33538. Color shall be homogeneous throughout the panel.
D. Truncated Dome Geometry

1. Truncated dome surface shall comply with Americans with Disabilities Act (ADA) Standards and California Building Code.

2. Truncated Dome Description:
   a. Pedestrian Grade Crossings and Curb Ramps:
      1) Square grid (in-line) pattern of raised truncated domes of 0.2-inch nominal height, base diameter of 0.9-inch and top diameter of 0.45-inch.
      2) Truncated domes shall have a center-to-center (horizontally and vertically) spacing of 2.35-inch as measured side by side in-line.
   b. Platforms:
      1) Staggered pattern of raised truncated domes of 0.2-inch nominal height, base diameter of 0.9-inch and top diameter of 0.45-inch.
      2) Truncated domes shall have a center-to-center spacing of 1.67-inch diagonally, and center-to-center (horizontally and vertically) spacing of 2.35-inch as measured side by side in-line.
   c. In order to ensure a uniform appearance of the detectable warning surface throughout the transit system, equivalent facilitation findings or alternate patterns will not be acceptable.

3. Truncated dome pattern shall align properly from panel to panel.

E. Panel Configuration

1. Panel Thickness
   a. At a minimum, the thickness of the body of Detectable Warning Panel shall measure 3/16-inch (0.1875-inch) nominal.

2. Panel Size
   a. Pedestrian Grade Crossings and Curb Ramps (In-Line Pattern):
      1) Nominal 36-inch x 48-inch (or longer) with a 7/16-inch thick deep flange along both long sides.
   b. Platforms (Staggered Pattern):
      1) Nominal 24-inch x 48-inch with a 7/16-inch thick deep flange along both long sides.
3. Butt Joints
   a. The detectable warning panel shall feature a butt joint detail from panel to panel. Alternatively a ship lap detail may also be furnished.

F. Fastener Holes in Panel
   1. Holes for fasteners shall be formed in the factory. Holes for fasteners, whether made in the factory or in the field, shall be located only at the centers of the truncated domes.

G. Performance
   1. Panels shall comply with the following performance characteristics:

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<th>Property</th>
<th>ASTM Test Method</th>
<th>Nominal Value</th>
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<tr>
<td>Wear Resistance</td>
<td>C501</td>
<td>500 (Min.)</td>
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<tr>
<td>Slip Resistance</td>
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<td>0.80 (Min.)</td>
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<td>Water Absorption</td>
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<tr>
<td>Tensile Strength</td>
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<td>Compressive Strength</td>
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<td>Flexural Strength</td>
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<td>Accelerated Weathering (3000 Hours)</td>
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<td>Delta E: 4.5 (Max.)</td>
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2.02 ACCESSORIES

A. Fasteners for Concrete
   1. Color matched nylon expansion sleeves with 1/4 inch diameter by 1-1/2 inches long stainless steel drive pins, or as recommended by panel manufacturer for specific job conditions and accepted by the Engineer.

B. Adhesive
   1. Type approved by panel manufacturer.

C. Sealant
   1. Urethane sealant of type approved by panel manufacturer.

D. Backer Rod
   1. Acceptable to sealant manufacturer. Where required, such as, at platform expansion joints.
PART 3 - EXECUTION

3.01 INSTALLATION

A. Apply adhesives, sealants and mechanical fasteners in strict accordance with the guidelines set by their respective manufacturers.

B. Utilize manufacturer-provided template to lay out area to receive panels.

C. Form recess for panels by either milling with diamond blade head or casting recess in place (at new paving) so that installed panel will still flush relative to adjacent surface. Grind or form to the depth and width required by the approved shop drawings and manufacturer's instructions. Finish cast-in-place recess with equivalent of a light broom finish. When milled, substrate shall have a light ribbed finish.

D. Contain and remove slurry resulting from concrete milling and saw cutting. Do not wash slurry into track bed area.

E. For Panels with Recessed Flanges:
   1. Utilize diamond bladed double headed wet saw to achieve parallel grooves to receive panels. Both saw cuts shall be made simultaneously from the same machine. Saw cut parallel to platform edge.
   2. After saw cutting, vacuum and power wash surface with clean clear water, free from all dirt and debris. Visually inspect surface for obtrusions or foreign matter. If obtrusions are present, remove by grinding. Remove foreign matter by grinding or further washing, as appropriate.
   3. Immediately prior to application of the setting adhesive, inspect surfaces to receive panel to ensure that they are clean, dry, free of voids, curing compounds, projections, loose material, dust, oils, grease, sealers, and other contaminants. Verify that surfaces are structurally sound and that concrete has cured a minimum of 30 days. Obtain panel manufacturer's representatives and Engineer's approval of surface preparation before installing panels.

F. Set panels and install fasteners in accordance with panel manufacturer's instructions and as follows:
   1. Wherever possible, install full size (uncut) panels. Do not install panel sections measuring less than 24 inches in length. Only cut panels where absolutely necessary.
   2. Maintain gap between panels for expansion and contraction in accordance with manufacturer's instructions.
3. At platform expansion joints, cut panels on their short sides, finish cut edges smoothly, and lay panels with cut edges aligned with the edges of the substrate along the joints. Install fasteners on either side of the expansion joint at the time of initial installation. After a minimum of 4 hours, make a saw cut measuring 5/16 inch wide across the composite detectable warning panel and fill with sealant. Make saw cut in the zone between truncated domes.

   a. Where there is platform curvature, composite detectable warning panels shall be treated in a similar manner so that the joints remain uniform across the width of the joint between successive panels. However, in areas of platform curvature, the joint shall take on somewhat of a triangular configuration.

4. Cutting through panel domes shall be kept to a minimum. Where less than half of the truncated dome remains, grind off balance of dome; where over half of the truncated dome remains, feather dome so as not to present a tripping hazard.

   G. Install sealant in accordance with manufacturer recommendations.

3.02 CLEANING AND PROTECTING

A. After the area has been fully paneled and sealant system applied, clean panel surface, following the manufacturer recommended maintenance and cleaning procedures.

B. Protect sealant and panels against damage during construction period. Comply with panel and sealant manufacturers' recommendations.

C. Protect panels against damage from rolling loads following installation by covering with plywood or hardwood.

D. Clean panel by method specified by manufacturer.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Detectable Warning Panels will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.
4.02 PAYMENT

A. Detectable Warning Panels furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 09 90 00
PAINTING AND COATINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Furnish all labor, materials, tools and equipment necessary and incidental to the painting, and finishing the surfaces as indicated on the Contract Drawings, as specified herein and as directed by the Engineer.

B. Painting shall include shop coat and field finish painting of all metal surfaces, including the complete canopy, railings, handrails, base plates, covers, connecting hardware, mounting brackets; field painting of railings and guardrails, fences, flashings, pipe bollards, and exposed mechanical or electrical equipment including housing; and the finish painting over shop coated exposed equipment.

C. Related Specification Sections include but are not necessarily limited to:
   1. Section 03 21 00 - Reinforcing Steel
   2. Section 05 52 00 - Handrails and Railings
   3. Section 09 25 00 - Gypsum Board
   4. Division 05 - Metals
   5. Division 26 - Electrical

1.02 REFERENCES

A. Comply with all applicable local, State and Federal Codes, regulations, specifications, standards and recommended practices, and in particular:
   1. ASTM - American Society for Testing and Materials
   2. Federal Specification

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00, Submittal Procedures:
   1. List of products: A complete list of products proposed for use on the project; include manufacturers’ product descriptions of all materials; obtain approval before proceeding. Use the same manufacturers’ products for all coats of each individual finish unless otherwise approved in writing by the Engineer.
2. Product data: Alternate manufacturers’ published literature for specified products and accessories as applicable, including manufacturers’ specifications, physical characteristics and performance data. Submit as a supplement, manufacturers’ instructions and directions for application if not included in the manufacturers’ published literature.

3. Samples: Of all paints and finishes proposed for use on the project, minimum size 8-1/2 inches by 11 inches.

1.04 QUALITY ASSURANCE

A. Application: Shall be by an experienced painter or a painting firm employing experienced personnel.

B. Conform to manufacturers’ specifications, directions and recommendations for best results in the use of each of their products for each condition. If results are at variance with Specifications, report the discrepancy to the Engineer for decision.

1.05 DELIVERY, HANDLING AND STORAGE

A. Delivery and storage: Deliver paint materials in unbroken, unopened containers bearing the manufacturers’ labels; do not open containers or remove labels until the Engineer inspects and approves. Store materials in a dry location where the indicated ambient temperature of storage is not less than 50 degrees Fahrenheit.

B. Precautions: Take extraordinary care to prevent fire; open containers or inflammable materials only as needed; keep rubbing cloths and oily rags in tightly closed metal containers, or remove from the site daily. Benzine, gasoline, and distillate will not be permitted on the job site.

C. Protection: Care shall be exercised in the handling of painting materials to ensure that this work and the work of other trades are not damaged before, during, or after the installation.

D. Replacements: Repair or replace damaged work, if any, as necessary to the approval of the Engineer at no additional cost to SCRRA.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. For metal surfaces paint materials shall be the products of Tnemec Co., Inc., or equal products by Ameron Protective Coatings Group, Rust-Oleum Industrial Coatings, Sherwin Williams, Porter International, or Pittsburgh Paints.

B. For gypsum board surfaces paint and stain materials shall be the products of Dunn-Edwards or equal products by Frazee Paint Co. or Sherwin Williams.

C. Materials selected for coating systems for each type of surface shall be the product of a single manufacturer.
D. All paint materials shall be the respective equivalent, in the opinion of the Engineer, to the several types of materials specified. Deliver all materials to the job site in the original, unbroken containers, bearing the manufacturers’ labels indicating the contents and directions for use, storage, and handling.

E. Materials not specifically noted but required for the work, such as linseed oil, shellac, thinners, etc., shall be the product of the approved paint manufacturer.

2.02 MIXING

A. Mix paint products according to the manufacturers’ painted directions. Do not adulterate in any manner except upon specific approval of, and in the presence of the Engineer.

2.03 COLOR SELECTION

A. The color selection will be made by the Engineer from submitted manufacture's standard colors.

B. Submit color samples requested by the Engineer, allowing ample time for consideration before the material to be painted is delivered or ready for painting.

2.04 IDENTIFICATION

A. The manufacturers’ identification numbers and specifications listed are for the purpose of indicating the type and quality of paint product desired for the purpose indicated.

PART 3 - EXECUTION

3.01 GENERAL

A. Apply paints in accordance with the manufacturers’ recommendations as to the application, weather, and temperature conditions. Provide “highest” quality workmanship performed to the Engineer’s satisfaction. Use clean equipment and brushes when applying paint; spread paint materials evenly, without runs, sags, laps, or brush marks, without variations in color, texture, or sheen, and without “holidays.”

B. Vary colors or sheen between coats and apply all coats to uniform thicknesses.

C. Cut sharp lines against glass, other materials, and different colors. Reccoat suction spots in the first coat as necessary to produce uniformity of color and gloss.

D. Refinish any work judged defective at no additional cost to SCRRA; repair all work damaged during the progress of the construction.

E. Leave finished surfaces clean, completely covered, uniform in appearance, and satisfactory to the Engineer.
3.02 SURFACE PREPARATION

A. General: Clean all surfaces thoroughly, removing all rust, mill scale, fabrication films, dust, dirt, and other foreign matter from surfaces. Grind smooth all welds flush with adjacent surfaces. Apply film to completely dry surfaces.

B. Galvanized metal: Thoroughly clean surfaces, wiping with mineral spirits or xylol. If silicone surface treatments have been applied in the fabrication shop, use xylol; remove silicates or similar surface treatments and deposits of "white rust" by sanding or other approved abrasive methods. Thoroughly clean and rinse contaminants from surfaces.

C. Ferrous metal surfaces: Thoroughly clean using mineral spirits, xylol, or toluol in accordance with SSPWC-SP No. 1. Take care to ensure that adequate ventilation is provided at all times when using solvents. Carefully rinse and clean surfaces before applying paint.

D. Gypsum Board:
   1. Remove dust, loose particles or other matter that would prevent proper paint adhesion.
   2. Check to see that joints and screw heads are properly covered with joint compound and sanded smooth and flush with adjacent surfaces.

E. Condition of surfaces: Inspect and approve conditions of substrate surfaces scheduled to receive paint; notify the Engineer of any surfaces unsuitable for application as specified. The application of a Paint finish constitutes an acceptance of the surface as suitable, unless directed to proceed in writing by the Engineer. The work shall not be performed during wet or freezing weather, or until surfaces have thoroughly dried from the effect of such weather.

F. Mixing and thinning: Mix and thin paint products in strict accordance with the manufacturers' directions; mix and thin other materials in accordance with the "best" trade practices as approved.

3.03 APPLICATION

A. Number of coats: As specified for each type of finish.

B. Thickness of coats: Use ample undiluted materials; apply in a uniform thickness over entire areas; do not exceed the manufacturers’ recommended spreading rate per gallon. Comply with DFT specified.

C. Color of coats: Tint prime coats if necessary to obtain uniform finish coats. Vary color between coats; the final coat shall exactly match approved samples.

D. Approval of successive coats: Obtain the Engineer's approval of each coat before the succeeding coat is applied; if this approval is not obtained, the Engineer reserves the right to require an additional coat.
3.04 MECHANICAL OR ELECTRICAL EQUIPMENT
   A. Apply primer and 2 finish coats as specified for the appropriate metal surface according to the finish schedule.

3.05 PROTECTION OF FINISHED WORK
   A. Use tarpaulins or drop cloths when working above or adjacent to completed work. Clean all paint splatters and stains from finished surfaces. Protect all work from dust and insects.

3.06 METAL SURFACES
   A. General: Provide the following paint systems for the various substrates, as indicated.
   B. Surface preparation not performed under other Sections: SSPWC-SP11 Power Tool Cleaning to bare metal all welds and damaged prime coat.
   C. Paint system:
      1. Spot prime for galvanized surfaces and surfaces primed with zinc-rich primer: 90-97 Tneme-Zinc applied at 2.5 to 3.5 mils DFT.
      2. First coat: Tnemec 60 Epoxoline applied at 4 to 6 mils DFT.
      3. Top coat: Tnemec 75 Endura-Shield applied at 2 to 3 mils DFT.

3.07 GYPSUM BOARD
   A. First coat: PVA sealer
   B. Second coat: 100% acrylic
   C. Third coat: 100% acrylic

PART 4 – MEASUREMENT AND PAYMENT

Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
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PART 1 - GENERAL

1.01 SUMMARY

A. Section includes: Contractor furnishing all materials, labor and equipment necessary and incidental to surface preparation, furnishing and application of a clear graffiti-resistant coating to all accessible concrete, masonry, and porous surfaces from finish grade or floor to 10 feet above finish grade or floor.

B. Related Specification Sections include but are not necessarily limited to:

1. Coordinate the work of this Section with all other Sections of this Specification.

1.02 REFERENCES

Comply with all applicable local, State and Federal Codes, regulations, specifications, standards and recommended practices, and in particular:

1. ASTM - American Society for Testing and Materials

1.03 SUBMITTALS

Submit the following in accordance with Section 01 33 00, Submittal Procedures.

A. Materials: Copies of a manufacturer's data.

B. Samples: 24 in. square samples of coating applied to same substrates as the Project. Coat one half of each sample and identify the coated side.

C. Certification: Duplicate copies of manufacturer's affidavit with each shipment of materials delivered to the jobsite certifying that material furnished complies with specified requirements.

D. Manufactures Instructions: Copies of the manufactures instructions for graffiti removal and maintenance.

1.04 QUALITY ASSURANCE

Sample panel:

1. Apply sample finish, approximately 10 ft. square, to wall areas, as directed by the Engineer.

2. Obtain Engineer's approval of sample panel before proceeding further.
Approved sample panel will be used as a standard for the Project, and if properly identified may remain a part of the Work.

1.05 **DELIVERY, STORAGE AND HANDLING**

Take all necessary precautions to prevent fire. Remove soiled rags and other waste items from premises at end of each day's work, or store in metal containers with tightly fitting metal covers.

1.06 **JOB CONDITIONS**

Environmental requirements:

A. Compliance with air quality regulations: VOC of coatings used for this work shall not exceed limits prescribed by law.

B. Comply with coating manufacturer’s recommendations for environmental conditions regarding coating application.

C. Do not apply finish in areas where dust is being generated.

D. Provide drop cloths, shields, barricades and other protection necessary to safeguard adjacent surfaces not to be coated. Post signs immediately after coating.

E. Provide and maintain protection as required to protect finished work from damage until its acceptance.

1.07 **MAINTENANCE**

A. With closeout submittals, deliver one identified unopened gallon container of graffiti-resistant coating, and a 5 gallon container of cleaner to be used for graffiti removal, to Engineer. Label container with material type and area where used for future identification.

B. Provide Engineer a copy of instructions for graffiti removal and maintenance recommendations.

**PART 2 - PRODUCTS**

2.01 **COATING**

Sacrificial: SC-1 or SC-1X by ProSoCo, or equal as approved by the Engineer.

1. Color: Standard Color as selected by the Engineer.

**PART 3 - EXECUTION**

3.01 **INSPECTION**

Examine surfaces to be coated for conditions that would adversely affect the
permanence and quality of this work. Make sure that unsuitable conditions are corrected before proceeding with painting.

3.02 SURFACE PREPARATION

Prepare surfaces to receive the coating in compliance with the coating manufacturer's printed instructions.

3.03 COATING PREPARATION

A. Open containers only as required for use. Mix coating in designated areas.

B. Thoroughly stir and agitate coating to uniformly smooth consistency suitable for proper application.

C. Do not reduce, change or use any materials except in compliance with manufacturer's printed instructions.

D. In all cases, prepare and handle coating to prevent deterioration and inclusion of foreign matter.

3.04 APPLICATION

A. Test coating on each type of substrate for compatibility and desired results before proceeding further.

B. Apply coating only under conditions that will insure finishes free from blemishes and defects.

C. Remove spillage and spatters on adjacent surfaces so as not to damage the surface being cleaned.

D. Completed work shall match approved samples, as determined by the Engineer.

PART 4 – MEASUREMENT AND PAYMENT

Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 10 14 53
ROADWAY SIGNS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Section Includes:
   1. Traffic signs.
   2. Accessories including but not limited to frames, brackets, supports, sign posts, cabinets, connectors, fasteners, and anchors.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 – General Requirements.
   2. Section 01 33 00 – Submittal Procedures.
   3. Section 01 60 00 – Product Requirements

1.02 REFERENCES

A. American Institute of Steel Construction (AISC):
   1. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges, Section 10, Architecturally Exposed Structural Steel.

B. ASTM International (formerly American Society for Testing and Materials):
7. A500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
9. A666 – Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

C. American Welding Society (AWS):

D. CE – U.S. Army Corps of Engineers:

E. Society for Protective Coatings (SSPC):
1. Paint 20 – Specification for Zinc Rich Primers (Type I, Inorganic, and Type II, Organic)
2. SP 6 – Commercial Blast Cleaning

1.03 SUBMITTALS

A. Make submittals in accordance with Section 01 33 00: Submittal Procedures.

B. Product Data: Technical product specifications, anchor details and installation instructions for products used in metal fabrication, including paint products, hinges, locks, fasteners, light fixtures, and other components of work.

C. Coating Systems:
1. Include finish manufacturer’s technical information such as basic materials analysis and installation instructions.

2. List each material and cross-reference to the specific coating, finish system and application.

3. Identify by manufacturer’s catalog number and general classification.

D. Shop Drawings:

1. Submit Shop Drawings for fabrication and erection indicating all materials, sizes, configurations and required location of connections, junction boxes, and equipment provided under other Sections.
   a. Include plans, elevations, details, sections, and connections.
   b. Show anchorage and accessory items.
   c. For structural elements, show fabrication and erection tolerances.

2. For structural elements, include details of cuts, connections, camber, holes, and other pertinent data.
   a. Indicate welds by standard AWS symbols, and show size, length, and type of each weld.

3. Provide setting Plans, templates, and directions for the installation of anchor bolts and other anchorages to be installed by others.

4. For connections designed by the fabricator as a part of fabricator’s preparation of Shop Drawings, show stamp and signature of a structural engineer registered in California.

5. Show approval of lighting supplier for all illuminated signs.

6. Include porcelain enameled steel panels, indicating method and sequencing of attachment.

7. Equipment Provided by Others: Show all equipment and accessory items provided by AUTHORITY or provided under other contracts.

E. Samples: Representative samples of materials and finished products.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide work required under this section from sign manufacturers regularly engaged in work of this magnitude and scope for minimum of five years.

B. Qualifications for Welding Work: Qualify welding processes and welding operators in accordance with the AWS Standard Qualification Procedure.
C. Uniformity of Manufacture: For each component and process indicated, furnish products of a single manufacturer.

D. Notify Engineer 15 days prior to 90 percent completion of the shop fabrication, so that the work may be observed prior to delivery to job site.

1. Where fabrication is done more than 100 miles (160 kilometers) from job site, allow 14 days for observation and review before fabrication and installation of additional units.

1.05 PROJECT CONDITIONS

A. Take field measurements prior to preparation of Shop Drawings and fabrication, where possible.

B. Do not delay job progress; allow for trimming and fitting wherever taking field measurements before fabrication might delay work.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect sign units during transportation to AUTHORITY by wrapping all sign units individually in soft, nonabrasive material.

B. Pay special attention to protection of sign faces with artwork and to porcelain enamel finish.

PART 2 - PRODUCTS

2.01 GENERAL

A. Where products or manufacturers are listed, make submittals for proposed comparable products and substitutions in accordance with Section 01 60 00, Product Requirements.

2.02 MATERIALS

A. Provide metal work composed of metals of the forms and types which comply with requirements of referenced standards and which are free from surface blemishes where exposed to view in the finished unit.

1. Exposed to view surfaces exhibiting pitting, seam marks, roller marks, “oil canning,” stains, discolorations, or other imperfections on finished units are not acceptable.

B. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666, Type 304.

C. Aluminum: Alloy and temper recommended by aluminum producer or finisher for type of use and finish indicated, and with minimum strength and durability properties of alloy and temper designated for each aluminum form required:
1. **Sheets:** ASTM B209, 5052-H32, panel quality, thickness as indicated on Plans.

2. **Extruded Pipe and Tube:** ASTM B429 (B429M), 6063-T6.

3. **Extruded Bar and Shapes:** ASTM B221, 6063-T6.

4. **Plate and Sheet:** ASTM B209, 6061-T6.

D. **Steel Plates, Shapes, and Bars:** ASTM A36 (A36M).

E. **Galvanizing:** G60 (Z180) zinc coating for steel fabrications; where zinc coating is reduced below average thickness required by applicable standard referenced above, apply galvanizing repair paint as specified.

1. **Preparation for Shop Finishing:** After galvanizing, thoroughly clean ornamental metalwork of grease, dirt, oil, flux and other foreign matter, and treat with metallic phosphate process.

F. **Fasteners:** Provide Type 304 or 316 stainless steel fasteners for exterior use and zinc plated fasteners with coating complying with ASTM B633, Class Fe/Zn 5, where built into exterior walls. Select fasteners for type, grade, and class required.

1. Do not use metals which are corrosive or otherwise incompatible with metals joined.

2. Provide tamper resistant fasteners where exposed to view.

3. Provide concealed fasteners for interconnection of metal work components and for attachment to other work except where exposed fasteners are or are unavoidable.

G. **Welding Electrodes and Filler Metal:** Type and alloy of filler metal and electrodes as recommended by producer of metal to be welded, complying with applicable AWS Specifications, and as required for color match, strength and compatibility in the fabricated items.

H. **Anchors and Inserts:** Provide anchors of type, size, and material required for type of loading and installation condition shown, as recommended by manufacturer, unless otherwise indicated.

1. Use nonferrous metal or hot dipped galvanized anchors and inserts for exterior locations and elsewhere as required for corrosion resistance.

2. Use toothed steel or expansion bolt devices for drilled-in-place anchors.

I. **Very High Bond (VHB) Adhesive:** VHB adhesives recommended by manufacturer.
J. Nonshrink, Nonmetallic Grout: Premixed, factory packaged, nonstaining, noncorrosive, nongaseous, gypsum free grout complying with CE CRD-C621.
   1. Provide grout specifically recommended by manufacturer for interior and exterior applications as indicated on Plans.

K. Galvanizing Repair Paint: High zinc dust content paint for regalvanizing welds in steel, complying with SSPC-Paint 20; two-component, moisture-cured urethane, zinc-rich.
   2. Manufacturers: Subject to compliance with requirements, provide the indicated product, a comparable product by one of the following, or equivalent approved as a substitution:
      a. Tnemec Company, Inc.

L. Traffic Signs: Minimum 0.067 inch thick (aka 14 gauge) sheet steel and reflectorized porcelain white beaded background and black lettering; size required by sign type and Caltrans Standard Specifications Section 56-2.
   1. Post Mounted: 2 inch by 2 inch by 1/8 inch (50 mm by 50 mm by 3 mm) galvanized steel pipe complying with ASTM A53; theft proof fasteners; set in concrete footing.

2.03 FABRICATION

A. Use materials of size and thickness indicated or as required to produce strength and durability in finished product for use intended.
   1. Work to dimensions shown or accepted on Shop Drawings, using proven details of fabrication and support.
   2. Use types of materials shown or specified for various components of work.
   3. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible.
      a. Use exposed fasteners of type shown.
   4. Provide anchorage of type shown, coordinated with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.
   5. Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware and similar items.
6. Fabricate units to configurations indicated on reviewed Shop Drawings.

7. Properly mark and match mark materials for field assembly.
   a. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.

8. Cut, fit, and assemble units with exposed surfaces smooth and square, free of cutting marks, shear distortion, burrs and nicks.

9. Form exposed work true to line and level with accurate angles, surfaces, and edges.
   a. Ease exposed edges to radius of approximately 1/32 inch (0.8 mm) unless otherwise shown.
   b. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

10. Form simple and compound curves by bending members in jigs or other system to produce uniform curvature for each repetitive configuration required.
    a. Maintain profile of member throughout entire bend without buckling, twisting, or otherwise deforming exposed surfaces.

B. Steel Fabrication: Fabricate with special care using material selected for best appearance, in accordance with AISC specifications and as indicated on final Shop Drawings.

   1. Apply necessary fabricating techniques to produce and maintain the quality of work within required tolerances.

   2. Fabrication Tolerances: As specified in AISC Code, Section 10, Architecturally Exposed Structural Steel, unless more stringent requirements are indicated.

   3. Hot-dip galvanize after fabrication.

C. Aluminum Fabrication: Allow for thermal movement in the design, fabrication, and installation of installed metal assemblies to prevent buckling, opening up of joints and over stressing of welds and fasteners.

   1. Base design calculations on actual surface temperatures of metals due to both solar heat gain and night time sky heat loss.

   2. Provide necessary rebates, lugs, and brackets for assembly of units.
      a. Use concealed fasteners wherever possible.

   3. Mill joints to a tight, hairline fit. Cope or miter corner joints.
a. Form joints exposed to weather to exclude water penetration.

4. Finish exposed surfaces to smooth, sharp, well-defined lines and arises.

D. Welded Construction: Comply with AWS Code for procedures, appearance, and quality of welds, and methods used in correcting welding work.

1. Select weld sizes, sequence and equipment to limit distortions to allowable tolerances.
   a. Surface bleed of back side welding on exposed surfaces will not be acceptable.

2. Assemble and weld by methods that produce true alignment of axes without warp.
   a. Grind smooth exposed fillet welds; grind butt welds flush and smooth; dress all exposed welds, feather edges onto base material and polish as required for smooth painted surfaces.

3. Provide shapes and sizes as required for profiles shown.
   a. Fabricate units from structural steel or aluminum shapes, plates, and bars, with continuously welded joints and smooth exposed edges.
   b. Use concealed field splices wherever possible.
   c. Provide cutouts, fittings, and anchorages as required for coordination of assembly and installation with other work.

4. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels, and miscellaneous steel and iron shapes as required for supporting of signs.

5. Fabricate items of sizes, shapes, and dimensions required.

6. Weld corners and seams continuously, complying with AWS recommendations.
   a. All exposed welds to be clean, consistent and uniform in appearance.
   b. Grind exposed welds to match adjacent contours and finish to match adjacent finish.

E. Holes for Other Work: Provide holes required for securing other work to sign supports, brackets and frames, and for passage of other work through metal members as shown on approved Shop Drawings.

1. Provide threaded nuts welded to framing, and other specialty items as shown to receive other work.
2. Drill holes 1/16 inch (1.6 mm) oversize for field alignment and fitting.

3. Cut, drill or punch holes perpendicular to metal surfaces.

4. Do not flame cut holes or enlarge holes by burning.

F. Bearing Plates: Provide bearing plates for steel items bearing on concrete construction, made flat, free from warps or twists, and of required thickness and bearing area.

   1. Drill plates to receive anchor bolts and for grouting as required.

G. Furnish inserts and anchoring devices which must be set in concrete for installation of metal work. Coordinate delivery with other work to avoid delay.

H. Surface Preparation: After inspection and before finishing, remove loose rust, mill scale, and deposits of spatter, slag, or flux.

   1. Clean steel and aluminum by wheel abrader process or other method to achieve results defined by SSPC-SP 6, Commercial Blast Cleaning.

PART 3 - EXECUTION

3.01 EXAMINATION

   A. Verify that mounting surfaces are properly prepared.

3.02 PREPARATION

   A. Do not start work until conditions are satisfactory.

   B. Take field measurements prior to preparation of Shop Drawings and fabrication, where possible.

      1. Do not delay job progress; allow for trimming and fitting where taking field measurements before fabrication might delay work.

   C. Coordinate and furnish anchorages, setting Plans, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction.

      1. Coordinate delivery of such items to project site.

3.03 FINAL ASSEMBLY

   A. Porcelain Panels: Assemble all porcelain enamel sign components flush, true and accurately straight as indicated on approved Shop Drawings for each type of sign.

   B. Hardware:
1. Furnish and install all hardware for the attachment of porcelain panels to other sign components.

2. In addition, furnish any other hardware item not specified which would normally be furnished or required for proper functioning of signs as indicated on the Plans.

C. Anchor Bolts:
   1. Furnish anchor bolts and other connectors required for securing sign supports to in-place work.
   2. Furnish templates and other devices as necessary for pre-setting bolts and other anchors to accurate locations.

3.04 ROADWAY SIGNS

A. Install roadway signs in accordance with the Contract Documents, Caltrans Standard Specifications Section 56-2 or as directed by the Engineer. Set height of pole mounted signs and other way finding signs as specified by local agencies having jurisdiction or Authority for the indicated application.

B. All signs shall be of high intensity grade (Diamond Grade Reflective) with protective overlay film.

C. Existing signs and poles as shown on the plans shall be relocated to a new location (Protected) and reinstalled.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Roadway Signs will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Roadway Signs on posts will be measured by the unit from actual count. One or more sign panels mounted on a single post installation will be counted as a roadway sign-one post.

4.02 PAYMENT

A. Roadway Signs furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing
all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and
doing all work, as shown on the Plans, and as specified in these Specifications,
and as directed by the Engineer.

B. This price shall be full compensation for including multiple sign faces, sign post,
anchors, hardware, concrete post foundation, galvanizing, and fasteners
described by the Contract Documents and as directed by the Engineer.

END OF SECTION
SECTION 10 14 55

RAILROAD SIGNAGE

PART 1 - GENERAL

1.01 SUMMARY

A. This Section consists of furnishing all labor, materials and equipment necessary and incidental to maintaining existing railroad signage and constructing new railroad signage at the locations indicated in the reference Specifications, on the contract plans, and/or as directed by the Engineer.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.

2. Division 01 - General Requirements.

C. Work Included:

3. All Work associated with constructing new and maintaining existing railroad signage along the right-of-way, including excavation for signposts.

4. If the Contractor cannot construct the signage at the locations indicated in the plans or standards due to obstructions, clearance limitations or topography, request direction from Engineer.

1.02 SUBMITTALS

A. Submit, under the provisions of Division 1 the following information:

1. Compliance: Manufacturer or Supplier’s certifications stating that the Materials delivered to the site are in compliance with these Specifications.

2. Shop Drawings: Details of sign lettering, manufacturer’s information for materials, posts, foundations, anchor details (including anchorage) detail.

PART 2 - PRODUCTS

2.01 MATERIALS

A. The Contractor shall use materials and methods, which comply with the SCRRRA Engineering Standards (ES). Railroad signage shall conform to the following Standard Drawings:
1. Sign lettering shall conform to SCRRA ES1212, Arial Bold Lettering or to the SCRRA Engineering Standards drawing for a specific sign.

2. Derail switch target signage shall conform to SCRRA ES2610, Derailing Switch Target and ES2611, Derail Signs.

3. Derail switch notice signage shall conform to SCRRA ES2612, Derailing Switch Notice.

4. Safety lock indication signage shall be at the option of the Contractor, and approved by the Engineer.

5. Switch stand target colors shall conform to SCRRA ES2703, Color Indications of Targets and Lenses on Switch Stands.

6. Station train and locomotive position spot signs shall conform to SCRRA ES3301 through ES3330-06.

7. Other station signs shall conform to SCRRA ES3301 through ES3329.

8. Highway-railroad crossing crossbuck signs for public crossings shall conform to SCRRA ES4101, Highway-Railroad Crossing Crossbuck Signs.

9. Private, pedestrian and bicycle railroad grade crossing signs shall conform to SCRRA ES4102, Private, Pedestrian and Bicycle Railroad Grade Crossing Signs.

10. Private crossing closure notification sign shall conform to SCRRA ES4312, Private Crossing Closure Notification Signs.

11. Construction project funding identification signs shall conform to SCRRA ES5201, Construction Project Funding Identification Sign for locally and federally funded projects.

12. Sign post, anchors and fasteners shall conform to SCRRA ES5210, Details for Installing Signs at Grade.

13. Milepost signs shall conform to SCRRA ES5211, Milepost.

14. Permanent speed restriction signs shall conform to SCRRA ES5213, Permanent Speed Restriction Signs.

15. No trespassing signs shall conform to SCRRA ES5214, Warning Signs.

16. Stop, slow and resume speed flags and signs shall conform to SCRRA ES5215, Stop, Slow and Resume Speed Flags and Signs.

17. Whistling Point/Quiet zone signs shall conform to SCRRA ES5216, Whistling Point/Quiet Zone Sign.
18. Yard limit signs for terminal tracks shall conform to SCRRRA ES5217, Yard Limit Sign for Terminal Tracks.

19. Control Point (CP) limit signs and markings shall conform to ES5218, Control Point (CP) Limit Sign and Markings.

20. Flag stanchions shall conform to ES5219, Flag Stanchion.

21. Station signs for other than CTC territory shall conform to SCRRRA ES5222, Station Signs for Other Than CTC Territory.

22. Mechanical Limit and No Ride Zone signs shall conform to SCRRRA ES5223, Mechanical Limit and No Ride Zone Signs.

23. Warning paddles shall conform to ES5225, Warning Paddle.

24. Warning Signs for Underground Cables shall conform to SCRRRA ES5229.

25. Bridge, trestle and culvert number signs shall conform to SCRRRA ES6101, Bridge, Trestle and Culvert Numbers.

26. Radio channel sign shall conform to ES6103, Radio Channel Sign.

27. Tunnel exit sign shall conform to SCRRRA ES6104, Tunnel Exit Sign.

28. Tunnel numbers shall conform to SCRRRA ES6102, Tunnel Numbers.

29. Radio channel signs shall conform to SCRRRA ES6103, Begin Channel Sign.

30. ATS sign shall conform to SCRRRA ES8260, ATS Sign.


32. Begin CTC/End CTC sings shall conform to SCRRRA ES8291, Begin CTC/End CTC Sign.

33. Stop sign shall conform to SCRRRA ES8292, Stop Sign.

34. Block signal with “P” Plate signs shall conform to SCRRRA ES8545, Block Signal With “P” Plate.

35. Other signs shall be as referenced or as shown on the Contract Plans.

PART 3 - EXECUTION

3.01 MAINTENANCE AND PROTECTION OF EXISTING SIGNAGE

A. Maintain and protect in place the existing railroad signage until such time as it can be replaced with new signage, or relocated at a permanent location, as shown on
the Contract Drawings. Signs may be temporarily relocated to prevent their damage. Contractor must confer with the Engineer for proper location and orientation of relocated signs.

B. No existing signage shall be removed unless approved by the Engineer.

C. Any existing railroad Milepost, whistling Post/Quiet Zone, Permanent Speed Restriction, Yard Limit, Control Point, Radio Channel, ATS, Block Signal With “P” Plate, or Derail signs damaged by the Contractor’s operations must be replaced within 36 HRS at the Contractor’s sole expense. Any other signage damaged by the Contractor’s operations must be replaced within 8 days, at the Contractor’s expense. Signage not replaced or repaired within these time periods will be replaced by the Authority at the Contractor’s expense; the cost of such replacement will be deducted from any payment due the Contractor.

D. Placement of temporarily relocated and permanent signs shall comply with current editions of CPUC General Order 26 and 118.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Railroad Signs will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Railroad Signs on posts will be measured by the unit from actual count. One or more sign panels mounted on a single post installation will be counted as a roadway sign-one post.

4.02 PAYMENT

A. Railroad Signs furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. This price shall be full compensation for including multiple sign faces, sign post, anchors, hardware, concrete post foundation, galvanizing, and fasteners described by the Contract Documents and as directed by the Engineer.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. This Section consists of the Contractor furnishing all labor, materials, tools and equipment necessary and incidental to the provision and installation of benches and trash containers as indicated on the Contract Drawings, as specified herein and as directed by the Engineer.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 05 12 23 - Structural Steel
2. Section 05 55 00 - Miscellaneous Metal

1.02 REFERENCES

Comply with all local, State and Federal codes, regulations, specifications, standards and recommended practices and in particular:

1.03 SUBMITTALS

Submit the following in accordance with Section 01 33 00, Submittal Procedures.

A. Data: Submit copies of manufacturer's specifications giving sizes, materials, finishes, installation instructions.

B. Samples: Submit manufacturer's color chips for standard colors. The Engineer will select the color from the colors submitted.

1.04 DELIVERY

Delivery: Do not deliver benches or trash containers until the platform construction is ready for their installation.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Trash Containers: Manufacturer indicated in plans to match existing station trash containers or equal approved by the Engineer.

B. Benches: Manufacturer indicated in plans to match existing station benches or equal approved by the Engineer.
2.01 MATERIALS AND COMPONENTS

A. Trash Containers shall be blast resistant construction with high strength steel outer shell and compressive inner layer designed to absorb major blast energy with remaining blast energy vented upwards away from public. Trash container will have interior removable plastic trash bag.

B. Benches to be steel construction matching existing benches.

PART 3 - EXECUTION

3.01 INSPECTION

Verify conditions and measurements affecting the work of this Section at site. Make sure that detrimental conditions are corrected before proceeding with installation.

3.02 INSTALLATION

A. Install equipment plumb, level and secure in compliance with their manufacturer’s recommendations. Trash containers and benches are to be securely bolted to the concrete where they are installed.

B. Touch-up minor damage, or replace damaged parts. Replace, at no cost to SCRRRA, materials that are damaged beyond satisfactory field repair.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Benches will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Trash Containers will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.
4.02 PAYMENT

A. Benches furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Trash Containers furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 26 05 00
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Basic requirements for electrical systems, including lighting for all platforms, parking lots and landscape area, wayside power.

1. Site electrical.
2. Service Pedestals.
3. Building wire and connectors.
4. Outdoor Switchboard with Utility Metering Section/Electricity metering components.
5. Sleeves for electrical penetrations.
6. Cutting and patching for electrical construction.
7. Accessories required for a complete installation.
8. Training requirements.

B. Requirements of this Section apply to all Sections in Division 26, Electrical.

1.02 REFERENCES

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. NEMA 250, Enclosures for Electrical Equipment (1000 V maximum).


E. UL 508A, Industrial Control Panels.


1.03 DEFINITIONS

A. Product Types:

1. EMT: Electrical metal tubing, ANSI C80.3.
2. FMC: Flexible metallic conduit.
4. LFMC: Liquid tight flexible metal conduit.
5. RMC: Rigid metallic conduit, specifically rigid galvanized steel.
7. PVC-coated RMC: PVC-coated rigid galvanized steel.

B. For the purpose of providing material and installing electrical work the following definitions shall be used:

1. Outdoor area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.
2. Architecturally finished interior area; offices, laboratories, conference rooms, restrooms, corridors and other similar occupied spaces.
3. Non-architectural finished interior area: mechanical, electrical, pump rooms and other similar process type rooms.
4. Highly corrosive and corrosive area: areas identified in the drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.
5. Hazardous areas: Class I, II or III areas as defined in NFPA 70 (NEC).

1.04 SUBMITTALS

A. Shop Drawing Transmittal:

1. General Requirements:
   a. Provide manufacturer’s technical information on products and product model descriptive bulletin.
   b. Include data sheets with manufacturer’s name and product model number, clearly identify all optional accessories.
c. Acknowledgement that products are UL listed or are constructed utilizing UL recognized components.
d. Manufacturer’s delivery, storage, handling and installation instructions.
e. Product installation details.
f. See individual specification sections for additional requirements.
g. Dimensioned plans and sections or elevation layouts and single line diagram of electricity metering component assemblies.

**1.05 COORDINATION**

A. Provide functioning electrical systems in compliance with National Electrical Code (NEC), manufacturer’s instructions, performance requirements in Contract Documents, and modifications resulting from reviewed shop drawings and field coordinated Drawings.

B. Provide complete power and control raceway and wiring for all mechanical equipment electrical loads.

C. Provide 480Y/277 V, 208Y/120 V three phase and 120/240 V single phase electrical distribution system including raceways and boxes, wires, grounding and bonding, wiring devices as necessary for a complete, operative, functional electric system.

D. Coordinate chases, slots, inserts, sleeves, and openings for electrical supports, raceways, and cable with general construction work.

E. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work.
   1. Coordinate installation of large equipment that requires positioning before closing in the building.

F. Coordinate electrical service connections to components furnished by utility companies.

G. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for service entrances and electricity metering components.

H. Coordinate location of access panels and doors for electrical items concealed by finished surfaces.

I. Where electrical identification devices are applied to field finished surfaces, coordinate installation of identification devices with completion of finished surface.
J. Coordinate underground conduit installation with other trades.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Provide all components of a similar type by one (1) manufacturer.

2.02 MATERIALS

A. Electrical Equipment Support Pedestals and /or Racks:

1. Approved Manufacturers:
   a. Modular Strut:
      1) Unistrut Building Systems.
      2) B-Line.
      3) Globe Strut.

2. Material requirements:
   a. Modular strut:
      1) Galvanized steel: ASTM A123 or ASTM 153.
      2) Stainless Steel: AISI Type 316.
   b. Mounting hardware:
      1) Galvanized steel.
      2) Stainless steel.
   c. Anchorage as per Division 5.

2.03 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeve: ASTM A53 Type E, Grade B, Schedule 40, galvanized steel, plain ends.

PART 3 - EXECUTION

3.01 ELECTRICAL EQUIPMENT INSTALLATION

A. Install and wire all equipment, including pre-purchased equipment, and perform all tests necessary to assure conformance to the Plans and Specification Sections and ensure that equipment is ready for operation and safe for energization.
B. Comply with NECA 1.

C. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

D. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom and meet the minimum code requirements.

E. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

F. Equipment: Install to facilitate service, maintenance, and repair or replacement of components.
   1. Connect for ease of disconnecting, with minimum interference with other installations.

G. Right of Way: Give to raceways and piping systems installed at a required slope.

3.02 APPLICATIONS

A. Raceways:
   1. Outdoor Installations:
      a. Exposed: IMC, RMC.
      b. Concealed: IMC, RMC.
      c. Underground, Single Run: Concrete encased RNC with reinforcement as indicated on Plans.
      d. Underground, Grouped: Concrete encased RNC with reinforcement as indicated on Plans.
      e. Connection to Vibrating Equipment: LFMC.
      f. Boxes and Enclosures: NEMA 250, Type 3R or Type 4, unless otherwise indicated.

   2. Indoor Installations:
      a. Exposed: EMT except in wet or damp locations, use IMC.
      b. Concealed in Walls or Ceilings: EMT.
      c. In Concrete Slab: RNC, RMC.
      d. Below Slab on Grade or in Crawlspace: IMC, RMC.
e. Connection to Vibrating Equipment: FMC; except in wet or damp locations: LFMC.
f. Boxes and Enclosures: NEMA 250, Type 1, unless otherwise indicated.

3.03 RACEWAY AND CABLE INSTALLATION

A. Conceal raceways and cables, unless otherwise indicated, within finished walls, ceilings, and floors.

B. Keep legs of raceway bends in the same plane and keep straight legs of offsets parallel.

C. Use RMC elbows where RNC turns out of slab.

D. Use PVC-coated RMC for transition from underground to aboveground.

E. Install pull wires in empty raceways.
   1. Use oven polypropylene or monofilament plastic line with not less than 200 LB tensile strength.
   2. Leave at least 12 IN of slack at each end of pull wires.

F. Install interior telephone and signal system raceways, 2 IN trade size and smaller, in maximum lengths of 150 FT and with a maximum of two 90 degree bends or equivalent.
   1. Add pull boxes where necessary to accomplish this.

G. Connect motors and equipment subject to vibration, noise transmission, or movement with a maximum of 72 IN flexible conduit.
   1. Install LFMC in wet or damp locations.
   2. Install separate ground conductor across flexible connections.

H. Set floor boxes level and trim after installation to fit flush to finished floor surface.

3.04 WIRING METHODS FOR POWER, LIGHTING, AND CONTROL CIRCUITS

A. Use wiring methods specified below to the extent permitted by applicable codes as interpreted by authorities having jurisdiction.

B. Exposed Feeders: Insulated single conductors in raceway.

C. Concealed Feeders in Ceilings, Walls, Gypsum Board Partitions: Insulated single conductors in raceway.

D. Concealed Feeders in Concrete, Below Floors on Grade: Insulated single conductors in raceway.
E. Exposed Branch Circuits: Insulated single conductors in raceway.

F. Concealed Branch Circuits in Ceilings, Walls and Gypsum Board Partitions: Insulated single conductors in raceway.

G. Concealed Branch Circuits in Concrete, below Floors on Grade: Insulated single conductors in raceway.

H. Underground Feeders and Branch Circuits: Insulated single conductors in raceway.

I. Remote Control Signaling and Power-Limited Circuits, Classes 1, 2, and 3: Insulated conductors in raceway unless otherwise indicated.

3.05 WIRING INSTALLATION

A. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

3.06 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves where electrical raceways, cables, wireways, cable trays, or busways penetrate concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

C. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

D. Cut sleeves to length for mounting flush with both surfaces of walls.

E. Extend sleeves installed in floors 2 IN above finished floor level.

F. Size pipe sleeves to provide 1/4 IN annular clear space between sleeve and raceway or cable, unless indicated otherwise.

G. Seal space outside of sleeves with grout for penetrations of concrete or masonry.

   1. Promptly pack grout solidly between sleeve and wall so no voids remain.

      a. Tool exposed surfaces smooth; protect grout while curing.

H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Where sleeves are indicated, seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.

I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations.
1. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.

J. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

3.07 FIRESTOPPING

A. Apply firestopping to cable and raceway sleeves and other penetrations of fire rated floor and wall assemblies to restore original undisturbed fire resistance ratings of assemblies.

3.08 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations.

1. Perform cutting by skilled mechanics of trades involved.

B. Repair, refinish, and touch up disturbed finish materials and other surfaces to match adjacent undisturbed surfaces.

3.09 TRAINING PROGRAM

A. General Requirements:

1. The Contractor is responsible for training as outlined in this Section.
   a. Maintenance management classes shall take place prior to the occupancy of the facility, as required and approved by the SCRRA.
   b. Mechanics training will commence only after installation of equipment is complete at the facility.
   c. Training shall be conducted at location determined by SCRRA.
   d. Hours for training shall be between 7:00 a.m. and 7:00 p.m. unless specifically permitted otherwise.

B. The Contractor is responsible for ensuring that training instructors are not only familiar with technical information, but also able to utilize proper methods of instruction, training aids, audiovisuals, etc., to ensure effective presentations.

C. The Contractor is responsible for providing all training aids, audiovisual equipment, and visual aids for the conduct of these courses.

D. Training materials are to become the property of the SCRRA at the conclusion of training.

E. Submission and Approval of Training Plans:
1. The Contractor shall meet with SCRRA's quality assurance manager not later than three weeks prior to the start of formal training.
   a. At that time, Contractor will submit lesson plans and an outline of the training program and will demonstrate any training aids involved.
   b. Handouts are also to be presented for approval and provided later in a ratio of one per student.
   c. Each location shall receive a complete set of prints and schematics.

2. The Contractor will submit in writing his plans for meeting the Specification training requirements.
   a. The SCRRA's quality assurance manager will approve and then coordinate and schedule all training involved.

F. The Contractor will outline specific objectives for each of the courses that he is required to present.

1. The course should include sessions in safety and machine operation, as well as a comprehensive seminar teaching basic skills and knowledge of each operation.
   a. The course should include both classroom and practical exercise sessions and shall provide the mechanic with the basic knowledge necessary to utilize all training materials.
   b. The Contractor will provide a detailed schedule outlining the length and content of each of these sessions in accordance with the guidelines established.

2. The training program shall include familiarization with equipment operation and performance and detailed instruction in operation, maintenance, and test procedures.
   a. Training duration shall be as specified in Specification Sections.

G. Training related to electrical systems shall include, but not be limited to, the following:

1. A written test, as well as a hands-on demonstration of competence by the student.
2. Troubleshooting instruction.
3. Troubleshooting guides and protocols.
4. Maintainability demonstration for each system.
PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Basic Electrical Materials and Methods will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. All material, work and services included in Sections 26 05 50, Overcurrent Protection Devices; 26 06 00, Grounding and Bonding; 26 7 10, Seismic Controls for Electric Works; 26 07 50, Electrical Identification; 26 08 00, Electrical Testing; 26 14 00, Wiring Devices; 26 28 00, Overcurrent and Short Circuit Protective Devices; 26 28 16, Safety Switches; 26 28 90, Transient Voltage Suppression; 26 41 00, Enclosed Switches and Circuit Breakers; 26 42 00, Enclosed Controllers; 26 44 10, Switchboards; 26 44 20, Service Pedestals and Panelboards; 26 46 00; and Dry Type Transformers (600 V and Less) will be included in this Section and are considered incidental to work under this Section and will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer.

4.02 PAYMENT

A. Basic Electrical Materials and Methods furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 26 05 43

ELECTRICAL: EXTERIOR UNDERGROUND

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Material and installation requirements for:
   a. Manholes.
   b. Handhole.
   c. Underground conduits and ductbanks.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 01 - General Requirements.
2. Division 03 - Concrete.
3. Section 26 07 50 - Electrical Identification.
4. Section 26 06 00 - Grounding and Bonding.
5. Section 26 13 00 – Conduits, Raceways and Boxes.
6. Section 33 05 23 – Steel Casing.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. HB, Standard Specifications for Highway Bridges.

2. ASTM International (ASTM):

   a. 70, National Electrical Code (NEC).
4. Society of Cable Telecommunications Engineers (SCTE):
   a. 77, Specification for Underground Enclosure Integrity.

1.03 DEFINITIONS

A. Direct-buried conduit(s):
   1. Individual (single) underground conduit.
   2. Multiple underground conduits, arranged in one or more planes, in a common trench.

B. Concrete encased ductbank: An individual (single) or multiple conduit(s), arranged in one or more planes, encased in a common concrete envelope.

1.04 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   3. Fabrication and/or layout drawings:
      a. Provide dimensional drawings of each manhole indicating all specified accessories and conduit entry locations.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Prefabricated composite handholes:
      a. Quazite Composolite.
      b. Armorcast Products Company.
      c. Synertech.
2. Precast manholes and handholes:
   a. Utility Vault Co.
   b. Oldcastle Precast, Inc.
   c. Lister Industries.

3. Manhole and handhole and ductbank accessories:
   a. Neenah.
   b. Unistrut.
   c. Condux International, Inc.
   d. Underground Devices, Inc.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

2.02 MANHOLES AND HANDHOLES

A. Prefabricated Composite Material Handholes:
   1. Handhole body and cover: Fiberglass reinforced polymer concrete conforming to all test provisions of SCTE 77.
   3. Open bottom.
   4. Stackable design as required for specified depth.
   5. Cover:
      a. Engraved legend of "ELECTRIC" or "COMMUNICATIONS".
      b. Non-gasketed bolt down with stainless steel penta head bolts.
      c. Lay-in non-bolt down, when cover is over 100 LBS.
      d. One or multiple sections so the maximum weight of a section is 125 LBS.
   6. Cover lifting hook: 24 IN minimum in length.
B. Precast Manholes and Handholes:

1. Fiberglass reinforced polymer concrete or steel reinforced cement concrete structures:
2. AASHTO live load rating: H-20 for full deliberate vehicle traffic.
4. Solid bottom with a 12 IN x 12 IN or 12 IN DIA french drain in the bottom of each manhole.
5. Gasketed removable top slab with lifting eyes and cast in frame for cover.
6. Cover extension rings as required.
7. Cable pulling eyes opposite all conduit entrances.
   a. Coordinate exact location with installation contractor.

2.03 CONCRETE MANHOLE AND HANDHOLE ACCESSORIES

A. Cover and Frame:

2. AASHTO live load rating: H-20.
3. Diameter: 30 IN.
4. Cast the legend "ELECTRICAL" or "COMMUNICATIONS" into manhole and handhole covers.

B. Cable Racks and Hooks:

1. Material: Heavy-duty non-metallic (glass reinforced nylon).
2. Hook loading capacity: 400 LBS minimum.
3. Rack loading capacity: Four (4) hooks maximum.
4. Hook deflection: 0.25 IN maximum.
5. Hooks: Length, as required, with positive locking device to prevent upward movement.

C. Cable Pulling Irons:

1. 7/8 IN DIA hot-dipped galvanized steel.
2. 6000 LB minimum pulling load.

D. Ground Rods and Grounding Equipment: See Specification Section 26 06 00.

2.04 UNDERGROUND CONDUIT AND ACCESSORIES

A. Concrete: Comply with Division 03 Specifications.

B. Conduit: See Specification Section 26 13 00.

C. Duct Spacers/Supports:
   1. High density polyethylene or high impact polystyrene.
   2. Interlocking.
   3. Provide 2 IN minimum spacing between conduits.
   4. Accessories, as required:
      a. Hold down bars.
      b. Ductbank strapping.

PART 3 - EXECUTION

3.01 GENERAL

A. Drawings indicate the intended location of manholes and handholes and routing of ductbanks and direct buried conduit.
   1. Field conditions may affect actual routing.

B. Manhole and Handhole Locations:
   1. Approximately where shown on the Drawings.
   2. As required for pulling distances.
   3. As required to keep pulling tensions under allowable cable tensions.
   4. As required for number of bends in ductbank routing.
   5. Shall not be installed in a swale or ditch.
   6. Determine the exact locations after careful consideration has been given to the location of other utilities, grading, and paving.
7. Locations are to be approved by the Engineer prior to excavation and placement or construction of manholes and handholes.

C. Install products in accordance with manufacturer's instructions.

D. Install manholes and handholes in conduit runs where indicated or as required to facilitate pulling of wires or making connections.

E. Comply with Specification Section 33 05 24 for trenching, backfilling and compacting.

3.02 MANHOLES AND HANDHOLES

A. Prefabricated Composite Material Handholes:

1. For use in areas subjected to occasional non-deliberate vehicular traffic.

2. Place handhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than handholes footprint on all sides.

3. Provide concrete encasement ring around handhole per manufacturer's installation instructions (minimum of 10 IN wide x 12 IN deep).

4. Install so that the surrounding grade is 1 IN lower than the top of the handhole.

5. Size: As indicated on the Drawings or as required for the number and size of conduits.

6. Provide cable rails and pulling eyes as needed.

B. Precast Manholes and Handholes:

1. For use in vehicular and non-vehicular traffic areas.

2. Construction:

   a. Grout or seal all joints, per manufacturer's instructions.

   b. Support cables on walls by cable racks:

       1) Provide a minimum of two (2) racks, install symmetrically on each wall of manholes and handholes.

       a) Provide additional cable racks, as required, so that both ends of cable splices will be supported horizontally.
2) Equip cable racks with adjustable hooks: Quantity of cable hooks as required by the number of conductors to be supported.

c. In each manhole and handhole, drive 3/4 IN x 10 FT long copper clad ground rod into the earth with approximately 6 IN exposed above finished floor.

1) Drill opening in floor for ground rod.

2) Connect all metallic components to ground rod by means of #8 AWG minimum copper wire and approved grounding clamps.

3) Utilize a ground bar in the manhole or handhole if the quantity of ground wires exceeds three (3).

a) Connect ground bar to ground rod with a #2/0 AWG minimum copper wire.

3. Place manhole or handhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than manholes or handholes footprint on all sides.

4. Install so that the top of cover is 1 IN above finished grade.

a. Where existing grades are higher than finished grades, install sufficient number of courses of curved segmented concrete block between top of handhole and manhole frame to temporarily elevate manhole cover to existing grade level.

5. After installation is complete, backfill and compact soil around manholes and handholes.

6. Handhole size:

a. As indicated on the Drawings or as required for the number and size of conduits entering or as indicated on the Drawings.

b. Minimum floor dimension of 4 FT x 4 FT and minimum depth of 4 FT.

7. Manhole size:

a. As indicated on the Drawings or as required for the number and size of conduits entering or as indicated on the Drawings.
b. Minimum floor dimension of 6 FT x 6 FT and a minimum depth of 6 FT.

3.03 UNDERGROUND CONDUITS

A. General Installation Requirements:

1. Ductbank types per location:
   a. Reinforced concrete ductbank:
      1) Under aircraft pavement.
      2) Under railroads.
      3) As indicated in the Ductbank Schedule.
   b. Concrete encased ductbank:
      1) Under roads.
      2) Conduits containing medium voltage cables.
      3) Pad mounted transformer secondaries.
      4) Plant process equipment feeders and controls.
      5) As indicated in the Ductbank Schedule.
   c. Direct-buried conduit(s):
      1) Area/Roadway lighting.
      2) As indicated in the Ductbank Schedule.

2. Do not place concrete or soil until conduits have been observed by the Engineer.

3. Ductbanks shall be sloped a minimum of 4 IN per 100 FT or as detailed on the Drawings.
   a. Low points shall be at manholes or handholes.

4. During construction and after conduit installation is complete, plug the ends of all conduits.

5. Provide conduit supports and spacers.
   a. Place supports and spacers for rigid nonmetallic conduit on maximum centers as indicated for the following trade sizes:
      1) 1 IN and less: 3 FT.
2) 1-1/4 to 3 IN: 5 FT.
3) 3-1/2 to 6 IN: 7 FT.

b. Place supports and spacers for rigid steel conduit on maximum centers as indicated for the following trade sizes:
   1) 1 IN and less: 10 FT.
   2) 1-1/4 to 2-1/2 IN: 14 FT.
   3) 3 IN and larger: 20 FT.

c. Securely anchor conduits to supports and spacers to prevent movement during placement of concrete or soil.

6. Stagger conduit joints at intervals of 6 IN vertically.

7. Make conduit joints watertight and in accordance with manufacturer's recommendations.

8. Accomplish changes in direction of runs exceeding a total of 15 degrees by long sweep bends having a minimum radius of 25 FT.
   a. Sweep bends may be made up of one or more curved or straight sections or combinations thereof.

9. Furnish manufactured bends at end of runs.
   a. Minimum radius of 18 IN for conduits less than 3 IN trade size and 36 IN for conduits 3 IN trade size and larger.

10. Field cuts requiring tapers shall be made with the proper tools and shall match factory tapers.

11. After the conduit run has been completed:
   a. Prove joint integrity and test for out-of-round duct by pulling a test mandrel through each conduit.
      1) Test mandrel:
         a) Length: Not less than 12 IN
         b) Diameter: Approximately 1/4 IN less than the inside diameter of the conduit.
   b. Clean the conduit by pulling a heavy duty wire brush mandrel followed by a rubber duct swab through each conduit.
12. Pneumatic rodding may be used to draw in lead wire.
   a. Install a heavy nylon cord free of kinks and splices in all unused new ducts.
   b. Extend cord 3 FT beyond ends of conduit.

13. Transition from rigid non-metallic conduit to rigid metallic conduit, per Specification Section 26 13 00, prior to entering a structure or going above ground.
   a. Except rigid non-metallic conduit may be extended directly to manholes, handholes, pad mounted transformer boxes and other exterior pad mounted electrical equipment where the conduit is concealed within the enclosure.
   b. Terminate rigid PVC conduits with end bells.
   c. Terminate steel conduits with insulated bushings.

14. Place warning tape in trench directly over ductbanks, direct-buried conduit, and direct-buried wire and cable in accordance with Specification Section 26 07 50.

15. Placement of conduits stubbing into handholes and manholes shall be located to allow for proper bending radiuses of the cables.

B. Concrete Encased Ductbank:

1. Ductbank system consists of conduits completely encased in minimum 2 IN of concrete and with separations between different cabling types as required in Specification Section 26 05 33 or as detailed on the Drawings.

2. Install so that top of concrete encased duct, at any point:
   a. Is not less than 24 IN below grade.
   b. Is below pavement sub-grading.

3. Where identified and for a distance 10 FT either side of the area, the concrete shall be reinforced.
   a. The reinforcement shall consist of #4 bars and #4 ties placed 12 IN on center, in accordance with Division 3 Specification Sections or as detailed on the Drawings.

4. Conduit supports shall provide a uniform minimum clearance of 2 IN between the bottom of the trench and the bottom row of conduit.
5. Conduit separators shall provide a uniform minimum clearance of 2 IN between conduits or as required in Specification Section 26 05 33 for different cabling types.

C. Direct-Buried Conduit(s):

1. Install so that the top of the uppermost conduit, at any point:
   a. Is not less than 30 IN below grade.
   b. Is below pavement sub-grading.

2. Provide a uniform minimum clearance of 2 IN between conduits or as required in Specification Section 26 05 33 for different cabling types.
   a. Maintain the separation of multiple planes of conduits by one of the following methods:
      1) Install multilevel conduits with the use of conduit supports and separators to maintain the required separations, and backfill with flowable fill (100 PSI) or concrete per Specification Section 03 31 00.
      2) Install the multilevel conduits one level at a time.
         a) Each level is backfilled with the appropriate amount of soil and compaction, per Specification Section 31 20 00, to maintain the required separations.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Manholes will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Handholes will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.
C. Measurement for Underground Conduits and Ductbanks will be included as an incidental to the work associated with Items in Section 26 13 00, Conduits, Raceways and Boxes and no separate measurement will be made to the Contractor for Work under this Section.

4.02 PAYMENT

A. Manhole furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Handholes furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

C. Payment for Underground Conduits and Ductbanks will be included as an incidental to the work associated with Items in Section 26 13 00, Conduits, Raceways and Boxes and shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 26 05 50
OVERCURRENT PROTECTIVE DEVICE COORDINATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Computer-based, fault-current, overcurrent protective device coordination studies, the setting of these devices and arc flash hazard report.
      a. Series-rated devices are prohibited.
      b. Fused circuit breakers are prohibited.
         1) Use breakers with adequate IC to interrupt worst case fault current they will encounter.

B. The Contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer or an approved engineering firm.

C. The Contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E-Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E, Annex D.

1.02 REFERENCES


B. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.


H. The National Fire Protection Association (NFPA):
   1. 70, National Electrical Code, latest edition.
   2. 70E, Standard for Electrical Safety in the Workplace.
I. Comply with IEEE 399 latest revision for general study procedures.
J. Comply with IEEE 242 latest revision for short-circuit currents and coordination time intervals.

1.03 SUBMITTALS FOR REVIEW/APPROVAL
A. Product Data: The short-circuit and protective device coordination studies shall be submitted to the Design Engineer prior to receiving final approval of the distribution equipment Shop Drawings and/or prior to release of equipment Drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the Engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.
B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
C. Qualification Data: For coordination-study specialist.
D. Other Action Submittals: 
   1. Coordination-study input data, including completed computer program input data sheets.
   2. Coordination study report.
   3. Arc Flash Hazard report.
   4. Equipment evaluation report.
   5. Setting report.
   6. Arc Flash Hazard Labels.

1.04 SUBMITTALS FOR CONSTRUCTION
A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report.
B. The Report shall include the following sections:
   1. Executive Summary.
   2. Descriptions, purpose, basis and scope of the study.
3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.

4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.

5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.

6. Details of the incident energy and flash protection boundary calculations.

7. Recommendations for system improvements, where needed.

8. One line diagram.

1.05 QUALITY ASSURANCE

A. Studies shall use computer programs developed as listed in Part 2.01 in this Section.

1. Software algorithms shall comply with requirements of standards and guides specified in this Section.

2. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications:

1. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

2. The Registered Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer or an approved engineering firm.

3. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.

4. The equipment manufacturer or approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

C. Testing Agency Qualifications:


   a. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise testing specified in Part 3.
D. Fault levels indicated on Drawings are for guidance only; device IC’s shall be determined from study results.

PART 2 - PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide computer software programs developed by one of the following, or equal approved as a substitution:

1. SKM Systems Analysis, Inc.
2. EDSA Micro Corporation.
3. ESA, Inc.
4. CYME International.

2.02 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399, Table 7-4.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices.

1. Optional Features:
   a. Arcing faults.
   b. Simultaneous faults.
   c. Explicit negative sequence.
   d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
B. Proceed with coordination study only after relevant equipment submittals have been assembled.
   1. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.

3.02 FAULT-CURRENT STUDY

A. Source Impedance:
   1. Utility company's fault-current contribution as indicated on Drawings.
   2. Downstream values indicated on Drawings are for guidance only.

B. Calculate momentary and interrupting duties on the basis of maximum available fault current.

C. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:
   2. Low-Voltage Fuses: IEEE C37.46.

D. Study Report: Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report.
   1. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3 PH, 2 PH, and phase-to-ground faults.

E. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices and conductors by comparing fault-current ratings of these devices with calculated fault-current momentary and interrupting duties.

3.03 COORDINATION STUDY

A. Gather and tabulate the following input data to support coordination study:
   1. Product Data for overcurrent protective devices specified in other Division 16 Sections and involved in overcurrent protective device coordination studies.
      a. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Impedance of utility service entrance.
3. Electrical distribution system diagram showing the following:
   a. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment.
   b. Circuit-breaker and fuse-current ratings and types.
   c. Relays and associated power and current transformer ratings and ratios.
   d. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
   e. Generator kilovolt amperes, size, voltage, and source impedance.
   f. Cables: Indicate conduit material, sizes of conductors, conductor insulation, and length.
   g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:
   a. Special load considerations, including starting inrush currents and frequent starting and stopping.
   b. Magnetic inrush current overload capabilities of transformers.
   c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
   d. Ratings, types, and settings of utility company's overcurrent protective devices.
   e. Special overcurrent protective device settings or types stipulated by utility company.
   f. Time-current-characteristic curves of devices indicated to be coordinated.
   g. Manufacturer: Frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
   h. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
i. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

B. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.

C. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.

D. Comply with IEEE 242 recommendations for fault currents and time intervals.

E. Transformer Primary Overcurrent Protective Devices:
   1. Device shall not operate in response to the following:
      a. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
      b. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
   2. Device shall protect transformer according to IEEE C57.12.00, for fault currents.

F. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242.
   1. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

G. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
   1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
      a. Device tag.
      b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
      c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
      d. Fuse-current rating and type.
      e. Ground-fault relay-pickup and time-delay settings.
2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between series devices, including power utility company's upstream devices. Show the following specific information:
   a. Device tag.
   b. Voltage and current ratio for curves.
   c. 3 PH and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.

3. Completed data sheets for setting of overcurrent protective devices.

3.04 OVERCURRENT PROTECTIVE DEVICE SETTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to assist in setting of overcurrent protective devices within equipment.

B. Testing: SCRRRA will engage a qualified testing agency to perform the following device setting and to prepare test reports.

1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:
   a. Verify that overcurrent protective devices meet parameters used in studies.
   b. Adjust devices to values listed in study results.

2. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 10.7 and 10.8 in NETA ATS.

C. All equipment provided shall meet or exceed the fault current level provided in the study.

3.05 ARCFLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E, Annex D.
B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 V and 208 V systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.

D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

F. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

G. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

H. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

I. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

3.06 ARC FLASH WARNING LABELS

A. The Contractor of the Arc Flash Hazard Analysis shall provide a 3.5 x 5 IN thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the Owner and after any system changes, upgrades or modifications have been incorporated in the system.
C. The label shall include the following information, at a minimum:

1. Location designation.
2. Nominal voltage.
3. Flash protection boundary.
5. Incident energy.
7. Engineering report number, revision number and issue date.

D. Labels shall be machine printed, with no field markings.

E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 600, 480 and applicable 208 V panelboard, one arc flash label shall be provided.
2. For each motor control center, one arc flash label shall be provided.
3. For each low voltage switchboard, one arc flash label shall be provided.
4. For each switchgear, one flash label shall be provided.
5. For medium voltage switches one arc flash label shall be provided.

3.07 ARC FLASH TRAINING

A. The Contractor of the Arc Flash Hazard Analysis shall train the Owner’s qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 HRS).

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 26 06 00
GROUNDING AND BONDING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Grounding and bonding of electrical and communications system and equipment.
   2. Accessories required for a complete installation.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 26 05 00 – Basic Electrical Materials and Methods
   2. Section 29 00 00 – Summary of Customer Information System (CIS) Work
   3. Section 29 20 20 – Communications Services

1.02 REFERENCES

A. ASTM International (ASTM):

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   1. 837, Standard for Qualifying Permanent Connections Used in Substation Grounding.

C. National Fire Protection Association (NFPA):
   1. 70, National Electrical Code (NEC).
      a. Article 230, Services.
      b. Article 250, Grounding and Bonding.
      c. Article 408, Switchboard and Panelboards.
      d. Article 409, Industrial Control Panels.
      e. Article 610, Cranes and Hoists.

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

1.03 QUALITY ASSURANCE

A. Assure ground continuity is continuous throughout the entire Project.

B. Regulatory Requirements:
   1. Electrical Components, Devices, and Accessories: Listed and labeled under UL 467 as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   2. Comply with NFPA 70.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

1.04 SUBMITTALS

A. Product Data: Technical data for ground rods and grounding conductors.

B. Reports: Field quality control test reports.

PART 2 - PRODUCTS

2.01 GENERAL

A. Where products and manufacturers are listed, make submittals for proposed comparable products and substitutions in accordance with:

   Section 01 33 00 - Submittal Procedures

   Section 01 25 00 - Substitution Procedures

   Section 01 60 00 - Product Requirements
2.02 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Ground rods and bars and grounding clamps, connectors and terminals:
   b. Burndy.
   c. Harger Lightning Protection.
   d. Heary Brothers.
   e. Joslyn.
   f. Robbins Lightning Protection.
   g. Thomas & Betts (Blackburn).
   h. Thompson.

2. Exothermic weld connections:
   b. Harger Lightning Protection.
   c. Thermoweld.

3. Prefabricated composite test stations:
   a. Quazite Composolite.
   b. Armorcast Products Company.

2.03 COMPONENTS

A. Wire and Cable:


2. Insulated conductors: Color coded green, per Specification Section 26 12 00.

3. For insulated conductors, comply with Section 26 12 00 - Conductors and Cables – Low Voltage.

5. Grounding Electrode Conductors: Stranded cable.

6. Underground Conductors: Bare, stranded, unless otherwise indicated.

7. Copper Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.

8. Copper Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 IN wide and 1/16 IN thick.

9. Tinned Copper Bonding Jumper: Tinned copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 IN wide and 1/16 IN thick.

10. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulated spacer.

11. Connectors: Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items. Use compression type where exposed and exothermic-welded type, in kit form, selected per manufacturer's written instructions where concealed or buried in earth.

B. Conduit: As specified in Specification Section 26 13 00.

C. Ground Bars:
   1. Solid copper:
      a. 1/4 IN thick.
      b. 2 or 4 IN wide.
      c. 24 IN long minimum in main service entrance electrical rooms, 12 IN long elsewhere.

   2. Predrilled grounding lug mounting holes.

   3. Stainless steel or galvanized steel mounting brackets.

   4. Insulated standoffs.

D. Ground Rods:
   1. Provide grounding electrodes as many as necessary to maintain maximum resistance as indicated in Section 3.02-4.

   2. 3/4 IN x 10 FT.

   3. Copperclad: Copper clad steel.
a. Heavy uniform coating of electrolytic copper molecularly bonded to a rigid steel core.

b. Corrosion resistant bond between the copper and steel.

c. Hard drawn for a scar-resistant surface.

E. Grounding Clamps, Connectors and Terminals:

1. Mechanical type:
   b. High copper alloy content.

2. Compression type for interior locations:
   b. High copper alloy content.
   c. Non-reversible.
   d. Terminals for connection to bus bars shall have two bolt holes.

3. Compression type suitable for direct burial in earth or concrete:
   b. High copper alloy content.
   c. Non-reversible.

F. Exothermic Weld Connections:

1. Copper oxide reduction by aluminum process.

2. Molds properly sized for each application.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Install products in accordance with manufacturer's instructions.

2. Size grounding conductors and bonding jumpers in accordance with NFPA 70, Article 250, except where larger sizes are indicated on the Drawings.
3. Remove paint, rust, or other non-conducting material from contact surfaces before making ground connections.

4. Where ground conductors pass through floor slabs or building walls provide non-metallic sleeves and install per Specification Section 01 73 20.

5. Do not splice grounding conductors except at ground rods.

6. Install ground rods and grounding conductors in undisturbed, firm soil.
   a. Provide excavation required for installation of ground rods and ground conductors.
   b. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.
   c. Unless otherwise specified, connect conductors to ground rods with compressor type connectors or exothermic weld.
   d. Provide sufficient slack in grounding conductor to prevent conductor breakage during backfill or due to ground movement.
   e. Backfill excavation completely, thoroughly tamping to provide good contact between backfill materials and ground rods and conductors.

7. Do not use exothermic welding if it will damage the structure the grounding conductor is being welded to.

B. Use copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

C. In raceways, use insulated equipment grounding conductors.

D. Exothermic Welded Connections: Use for connections to structural steel and for underground connections.

E. Grounding Bus: Install 24 IN long ground bus in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Use insulated spacer; space 1 IN from wall and support from wall 18 IN above finished floor.

F. Underground Grounding Conductors: Use copper conductor, No. 4/0 AWG minimum. Bury at least 24 IN below grade or bury directly below duct bank when installed as part of the duct bank.
G. Equipment Grounding Conductors: Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

1. Install insulated equipment grounding conductors in all feeders and branch circuits.

2. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch circuit runs from computer-area power panels or power-distribution units.

3. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

4. Air Duct Equipment Circuits: Install an insulated equipment grounding conductor to duct mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.

5. Water Heater, Heat Tracing, and Anti-frost Heating Cables: Install an insulated equipment grounding conductor to each electric water heater, heat tracing, and anti-frost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

6. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

7. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing an insulated equipment grounding conductor with supply branch-circuit conductors.

H. Metal Frame Grounding for Buildings: Drive a ground rod at the base of every corner column and at each intermediate exterior column. Connect rod to column with an underground grounding conductor. Interconnect ground rods with a continuous underground conductor (counterpoise), extending around the perimeter of the building, 24 IN minimum from building foundation. Use tinned copper conductor not less than No. 4/0 AWG for underground conductor, and bury 18 IN below grade, minimum.

I. Ground Rods: Drive ground rods until tops are 12 IN below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except as otherwise indicated. Make connections without exposing steel or damaging copper coating.
J. Grounding Conductors: Route along shortest and straightest paths possible. Avoid obstructing access or placing conductors where subjected to strain, impact, or damage.

K. Bonding Straps and Jumpers: Install so that vibration by equipment mounted on vibration isolation hangers or supports is not transmitted to rigidly mounted equipment. Use exothermic welded connectors for outdoor locations, unless disconnect type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

L. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

M. Water Meter Piping: Use braided type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

N. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided type bonding straps.

O. Bond each above ground portion of gas piping system upstream from equipment shutoff valve.

P. Connections: Make connections so that galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so that metals in direct contact will be galvanically compatible.

1. Use electroplated or hot tin coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.

2. Make connections with clean, bare metal at points of contact.

3. Make aluminum to steel connections with stainless steel separators and mechanical clamps.

4. Make aluminum to galvanized steel connections with tin plated copper jumpers and mechanical clamps.

5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

6. 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.
7. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure type connectors.

8. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

9. 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.

10. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

11. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

Q. Duct Banks: Install a No. 4/0 grounding conductor below each duct bank in direct contact with the earth.

R. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so that 4 IN will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 IN above to 6 IN below concrete. Seal floor opening with waterproof, non-shrink grout.

S. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

T. Pad Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad mounted equipment and noncurrent carrying metal items associated with substations by connecting them to...
underground cable and grounding electrodes. Use copper conductor not less than No. 4/0 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 IN below grade and 6 IN from the foundation.

### 3.02 FIELD QUALITY CONTROL

A. Leave grounding system uncovered until observed by Engineer.

B. Testing: AUTHORITY will engage independent agency to perform field quality control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground resistance level is indicated and at service disconnect enclosure grounding terminal. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall of potential method according to IEEE 81.

3. Provide Drawings locating each ground rod, ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

4. Nominal maximum values are as follows:
   
a. Equipment Rated 500 kVA and Less: 10 ohms.

b. Equipment Rated 500 to 1000 kVA: 5 ohms.

c. Equipment Rated More Than 1000 kVA: 3 ohms.


e. Manhole Grounds: 10 ohms.

### PART 4 - MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.
B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Seismic restraints and earthquake damage reduction measures for electrical components.
   2. Accessories required for a complete installation.

1.02 REFERENCES

A. ASTM International (ASTM):

B. State of California Earthquake Regulations:

1.03 DEFINITIONS

A. Seismic Restraint: A fixed device (a seismic brace, an anchor bolt or stud, or a fastening assembly) used to prevent vertical or horizontal movement, or both vertical and horizontal movement, of an electrical system component during an earthquake.

B. Mobile Structural Element: A part of the building structure such as a slab, floor structure, roof structure, or wall that may move independently of other structural elements during an earthquake.

1.04 SUBMITTALS

A. Product Data: Technical data illustrating and indicate types, styles, materials, strength, fastening provisions, and finish for each type and size of seismic-restraint component used. Include documentation of evaluation and approval of components by agencies acceptable to authorities having jurisdiction.
B. Shop Drawings: For components, physical arrangements, and installation details not defined by Drawings. Indicate materials and show calculations, design analysis, details, and layouts, signed and sealed by a Professional Engineer.

C. Field quality control test reports.

1.05 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in California Building Code unless requirements in this Section are more stringent.

B. Comply with MFMA-4 of the Metal Framing Manufacturers Association unless requirements of CBC or this Section are more stringent.

C. Testing Agency Qualifications: An independent testing and inspection agency, acceptable to Authorities Having Jurisdiction, with the experience and capability to conduct the inspection indicated.

1.06 PROJECT CONDITIONS

A. Project Seismic Zone and Zone Factor as Defined in CBC: 4.

B. Occupancy Category as Defined in CBC: Refer to Drawings.

C. Acceleration Factor as Defined in CBC: Refer to Drawings.

1.07 COORDINATION

A. Coordinate layout and installation of seismic bracing with building structure, architectural features, and mechanical, fire-protection, electrical, and other building systems.

B. Coordinate concrete bases with building structural system.

C. Coordination of Bracing Systems:

1. Transverse and longitudinal bracing for seismic forces on suspended electrical systems including conduit, cable tray, bus duct, and equipment.

2. Anchorage of floor and roof mounted electrical equipment.

D. Seismic Design Requirements:

1. Seismic design criteria: Provide bracing and anchoring for equipment, conduit, cable tray, bust duct, designed, constructed, and installed to resist stresses produced by lateral forces.

E. Design and install seismic anchorage and bracing for all floor or roof mounted equipment weighing 400 LBS or more and all suspended or wall mounted equipment weighing 20 LBS or more.
F.  The following components are exempt from the requirements of this Section:
   1. Electrical components in structures assigned to Seismic Design Category C provided that the importance factor (Ip) is equal to 1.0.
   2. Electrical components in Seismic Design Categories D, E, and F where Ip = 1.0 and flexible connections between the components and associated ductwork, piping, and conduit are provided and that are mounted at 4 FT (1.22 m) or less above a floor level and weigh 400 LBS (1780 N) or less.
   3. Electrical components in Seismic Design Categories D, E, and F weighing 20 LBS (95 N) or less where Ip = 1.0 and flexible connections between the components and conduit are provided, or for distribution systems, weighing 5 LBS/FT (7 N/m) or less.

G. Seismic forces shall be presumed to act through the center of mass of the equipment in a direction that will produce the largest single anchor force.

PART 2 - PRODUCTS

2.01 GENERAL
   A. Where products and manufacturers are listed, make submittals for proposed comparable products and substitutions in accordance with Section 01 60 00 - Product Requirements.

2.02 MATERIALS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved as a comparable product:
      1. Amber/Booth, a VMC Group company.
      3. Erico, Inc.
      4. GS Metals Corp.
      5. Loos & Co., Inc.
      6. Mason Industries, Inc.
      7. Powerstrut brand, Power Engineering Co., Inc.
      8. Thomas & Betts Corp.
B. Restraints:

1. Indoor Dry Locations: Steel, zinc plated.
2. Outdoors and Damp Locations: Galvanized steel.

2.03 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

A. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Strength in tension and shear of components shall be at least twice the maximum seismic forces for which they are required to be designed.

B. Concrete and Masonry Anchor Bolts and Studs: Steel expansion wedge type.

C. Concrete Inserts: Steel channel type.

D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A325.

E. Welding Lugs: Comply with MSS SP-69, Type 57.

F. Beam Clamps for Steel Beams and Joists: Double sided. Single sided type is not acceptable.

G. Bushings for Floor Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.

H. Bushing Assemblies for Wall Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

2.04 SEISMIC BRACING COMPONENTS

A. Slotted Steel Channel: 1-5/8 IN by 1-5/8 IN cross section, formed from 0.1046 IN thick steel, with 9/16 IN by 7/8 IN slots at a maximum of 2 IN OC in webs, and flange edges turned toward web.

3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.
4. Finish: Baked, rust-inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.

B. Channel Type Bracing Assemblies: Slotted steel channel, with adjustable hinged steel brackets and bolts.

C. Hanger Rod Stiffeners: Slotted steel channels, installed vertically, with internally bolted connections to hanger rod.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install seismic restraints according to applicable codes and regulations and as approved by Authorities Having Jurisdiction, unless more stringent requirements are indicated.

B. Install structural attachments as follows:

1. Use bolted connections with steel brackets, slotted channel, and slotted-channel fittings to spread structural loads and reduce stresses.

2. Attachments to New Concrete: Bolt to channel type concrete inserts or use expansion anchors.

3. Attachments to Existing Concrete: Use expansion anchors.

4. Holes for Expansion Anchors in Concrete: Drill at locations and to depths that avoid reinforcing bars.

5. Attachments to Solid Concrete Masonry Unit Walls: Use expansion anchors.

6. Attachments to Hollow Walls: Bolt to slotted steel channels fastened to wall with expansion anchors.

7. Attachments to Wood Structural Members: Install bolts through members.

8. Attachments to Steel: Bolt to clamps on flanges of beams or on upper truss chords of bar joists.

C. Install electrical equipment anchorage as follows:

1. Anchor panelboards, motor-control centers, motor controls, switchboards, switchgear, transformers, unit substations, fused power circuit devices, transfer switches, busway, battery racks, static uninterruptible power units, power conditioners, capacitor units, communication system components, and electronic signal processing, control, and distribution units as follows:
a. Anchor equipment rigidly to a single mobile structural element or to a concrete base that is structurally tied to a single mobile structural element.

b. Size concrete bases so that expansion anchors will be a minimum of 10 bolt diameters from the edge of the concrete base.

c. Concrete Bases for Floor Mounted Equipment: Use female expansion anchors and install studs and nuts after equipment is positioned.

d. Bushings for Floor Mounted Equipment Anchors: Install to allow for resilient media between anchor bolt or stud and mounting hole in concrete.

e. Anchor Bolt Bushing Assemblies for Wall Mounted Equipment: Install to allow for resilient media where equipment or equipment mounting channels are attached to wall.

f. Torque bolts and nuts on studs to values recommended by equipment manufacturer.

D. Install Seismic Bracing:

1. Install bracing according to spacings and strengths indicated by approved analysis.

2. Expansion and Contraction: Install to allow for thermal movement of braced components.

3. Attachment to Structure: If specific attachment is not indicated, anchor bracing to the structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

E. Accommodation of Differential Seismic Motion: Make flexible connections in raceways, cables, wireway, cable trays, and busway where they cross expansion and seismic control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate at electrical equipment anchored to a different mobile structural element from the one supporting them.

3.02 FIELD QUALITY CONTROL

A. Testing Agency: SCRRRA will engage a qualified testing and inspection agency to inspect seismic-control installation for compliance with indicated requirements.

B. Re-inspection: Correct deficiencies and verify by re-inspection that work complies with requirements.

C. Provide written report of tests and inspections.
PART 4 - MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 26 07 50

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes: Electrical identification.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with NFPA 70.

1.03 SUBMITTALS

A. Shop Drawings: Dimensioned plans and Sections or elevation layouts of electrical equipment.

1.04 COORDINATION

A. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

B. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

PART 2 - PRODUCTS

2.01 ELECTRICAL IDENTIFICATION

A. Identification Devices: A single type of identification product for each application category. Use colors prescribed by ASME A13.1, NFPA 70, and these Specifications.

B. Raceway and Cable Labels: Comply with ASME A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway and cable size.

1. Type: Pretensioned, wraparound plastic sleeves. Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the item it identifies.

2. Type: Preprinted, flexible, self-adhesive, vinyl. Legend is over-laminated with a clear, weather- and chemical-resistant coating.

3. Color: Black letters on orange background.

4. Legend: Indicates voltage.
5. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than 1 IN wide by 3 mils thick.

C. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:
   1. Minimum 6 IN wide by 4 mils thick.
   2. Compounded for permanent direct-burial service.
   3. Embedded continuous metallic strip or core.
   4. Printed legend that indicates type of underground line.

D. Tape Markers for Wire: Vinyl or vinyl cloth, self adhesive, wraparound type with preprinted numbers and letters.
   1. Color Coding Cable Ties: Type 6/6 nylon, self locking type. Colors to suit coding scheme.

E. Engraved Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16 IN minimum thickness for signs up to 20 SQ IN and 1/8 IN minimum thickness for larger sizes. Engraved legend in black letters on white background.


G. Preprinted, aluminum, baked enamel finish signs, punched or drilled for mechanical fasteners, with colors, legend, and size appropriate to the application.


I. Weather resistant, nonfading, preprinted, cellulose acetate butyrate signs with 0.0396 IN galvanized steel backing, with colors, legend, and size appropriate to the application. 1/4 IN grommets in corners for mounting.

J. Fasteners for Nameplates and Signs: Self tapping, stainless steel screws or No. 10/32 stainless steel machine screws with nuts and flat and lock washers.

**PART 3 - EXECUTION**

3.01 IDENTIFICATION INSTALLATION

A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project.
C. Self Adhesive Identification Products: Clean surfaces before applying.

D. Identify raceways and cables with color banding.

E. Bands: Pretensioned, snap around, colored plastic sleeves or colored adhesive marking tape. Make each color band 2 IN wide, completely encircling conduit, and place adjacent bands of two color markings in contact, side by side.

1. Band Locations: At changes in direction, at penetrations of walls and floors, at 50 FT maximum intervals in straight runs, and at 25 FT maximum intervals in congested areas.

2. Colors:
   c. Telecommunication System: Green and yellow.

F. Tag and label circuits designated to be extended in the future. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box. Color coding may be used for voltage and phase identification.

G. Install continuous underground plastic markers during trench backfilling, for exterior underground power, control, signal, and communication lines located directly above power and communication lines. Locate 6 to 8 IN below finished grade. If width of multiple lines installed in a common trench or concrete envelope does not exceed 16 IN overall, use a single line marker.

1. Color code 208Y/120-V system secondary service, feeder, and branch circuit conductors throughout the secondary electrical system as follows:
   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.

2. Color code 480Y/277-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:
   a. Phase A: Yellow.
   b. Phase B: Brown.
   c. Phase C: Orange.
H. Install warning, caution, and instruction signs where required to comply with 29 CFR 1910.145, and where needed to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal backed butyrate signs for outdoor items.

I. Install engraved laminated emergency operating signs with white letters on red background with minimum 3/8 IN high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

PART 4 - MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 26 08 00
ELECTRICAL TESTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. General requirements for electrical field testing and inspecting.
   2. Detailed requirements are specified in each Section containing components that require testing. General requirements include:
      a. Qualifications of testing agencies and their personnel.
      b. Suitability of test equipment.
      c. Calibration of test instruments.
      d. Coordination requirements for testing and inspecting.
      e. Reporting requirements for testing and inspecting.

1.02 REFERENCES

A. InterNational Electrical Testing Association (NETA):

B. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):

1.03 QUALITY ASSURANCE

A. Testing Agency Qualifications:
   1. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration, and adjusting of systems.
   2. Testing firm that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7 will be brought in by AUTHORITY to perform testing; Contractor will coordinate and cooperate with this group.
B. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.

1. Field personnel:
   a. Minimum of one (1) year field experience covering all phases of electrical equipment inspection, testing, and calibration.
   b. Relay test technician having previous experience with testing and calibration of relays of the same manufacturer and type used on project and proficient in setting and testing the types of protection elements used.

2. Supervisor certified by NETA or NICET.

3. Analysis personnel:
   a. Minimum three (3) years combined field testing and data analysis experience.
   b. Supervisor certified by NETA or NICET.

C. Test Equipment Suitability: Comply with NETA ATS, Section 5.2.

D. Test Equipment Calibration: Comply with NETA ATS, Section 5.3.

PART 2 - MATERIALS - (NOT APPLICABLE TO THIS SECTION)

PART 3 - EXECUTION

3.01 GENERAL TESTS AND INSPECTIONS

A. If a group of tests are specified to be performed by an independent testing agency, prepare systems, equipment, and components for tests and inspections, and perform preliminary tests to ensure that systems, equipment, and components are ready for independent agency testing. Include the following minimum preparations as appropriate:

1. Perform insulation-resistance tests.

2. Perform continuity tests.

3. Perform rotation test (for motors to be tested).

4. Provide a stable source of single-phase electrical power for test instrumentation at each test location.

B. Test and Inspection Reports: In addition to requirements specified elsewhere, report the following:

1. Manufacturer’s written testing and inspecting instructions.
2. Calibration and adjustment settings of adjustable and interchangeable devices involved in tests.

3. Tabulation of expected measurement results made before measurements.

4. Tabulation of "as-found" and "as-left" measurement and observation results.

PART 4 - MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 26 12 00

CONDUCTORS AND CABLES - LOW VOLTAGE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Material and installation requirements for:
   a. Building wire.
   b. Power cable.
   c. Control cable.
   d. Shielded VFD cable.
   e. Instrumentation cable.
   f. Fiber optic cable.
   g. Wire connectors.
   h. Insulating tape.
   i. Pulling lubricant.

2. Accessories required for a complete installation.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 01 - General Requirements.
2. Section 01 33 00 - Submittal Procedures.
3. Section 26 05 00 - Basic Electrical Materials and Methods.
4. Section 26 08 00 - Electrical Testing
5. Section 2613 00 – Conduits, Raceways, and Boxes

1.02 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. 1202, Standard for Flame-Propagation Testing of Wire and Cable.
B. Insulated Cable Engineers Association (ICEA):

C. National Electrical Manufacturers Association (NEMA):
   1. ICS 4, Industrial Control and Systems: Terminal Blocks.

D. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
   1. WC 57/S-73-532, Standard for Control Cables.

E. National Fire Protection Association (NFPA):
   1. 70, National Electrical Code (NEC).
   2. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

F. Telecommunications Industry Association/Electronic Industries Alliance (TIA/EIA):
   1. 598-C, Optical Fiber Cable Color Coding.

G. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
   1. 568, Commercial Building Telecommunications Cabling Standard.

H. Underwriters Laboratories, Inc. (UL):
   4. 486A, Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors.
   7. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

9. 2250, Standard for Safety Instrumentation Tray Cable.

1.03 DEFINITIONS

A. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

B. Instrumentation Cable:

1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.

2. The following are specific types of instrumentation cables:

   a. Analog signal cable:

      1) Used for the transmission of low current (e.g., 4-20mA DC) or low voltage (e.g., 0-10 Vdc) signals, using No. 16 AWG and smaller conductors.

      2) Commonly used types are defined in the following:

         (1) TSP: Twisted shielded pair.

         (2) TST: Twisted shielded triad.

   b. Digital signal cable: Used for the transmission of digital signals between computers, PLC's, RTU's, etc.

C. Power Cable: Multi-conductor, insulated, with outer sheath containing building wire, No. 8 AWG and larger.

D. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires, No. 14, No. 12 or No. 10 AWG.

E. Building Wire: Single conductor, insulated, with or without outer jacket depending upon type.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
   a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
      1) Wire connectors.
      2) Insulating tape.
      3) Cable lubricant.
   b. See Specification Section 26 05 00 for additional requirements.

1.05 QUALITY ASSURANCE

   A. Regulatory Requirements:
      1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
      2. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 MATERIALS

   A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
      1. Building wire, power and control cable and multiplex cable:
         a. Aetna Insulated Wire.
         b. Alphawire.
         c. Cerrowire.
         d. Encore Wire Corporation.
         e. General Cable.
         f. Okonite Company.
         g. Southwire Company.
2. Instrumentation cable:
   a. Analog cable:
      1) Alphawire.
      2) Belden Inc.
      3) General Cable.

3. Wire connectors:
   a. AFC Cable Systems, Inc., div. Tyco Electrical and Metal Products.
   b. Anderson Electrical Products, Inc., subsidiary Hubbell Incorporated
   c. Burndy Corporation.
   d. AMP brand, Tyco Electronics.
   e. Buchanan.
   f. Ideal.
   g. Ilsco.
   h. 3M Co.
   i. Teledyne Penn Union.
   j. Thomas and Betts.
   k. Phoenix Contact.
   l. O-Z/Gedney brand, EGS Electrical Group.

4. Insulating and color coding tape:
   a. 3M Co.
   b. Plymouth Bishop Tapes.
   c. Red Seal Electric Co.

B. Submit request for substitution in accordance with Specification Section 01 25 00.
2.02 MANUFACTURED UNITS

A. Building Wire:
   1. Conductor shall be copper with 600 V rated insulation.
   2. Conductors shall be stranded, except for conductors used in lighting and receptacle circuits which may be stranded or solid.
   3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 for type THHN/THWN and THHN/THWN-2 insulation.
   5. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 for type XHHW-2 insulation.

B. Power Cable:
   1. Conductor shall be copper with 600 V rated insulation. 75 DegC temperature rated insulation. Where installed in raceway exposed to direct sunlight outside of the buildings, provide minimum 90 DegC temperature rated insulation.
   2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   3. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
   4. Number of conductors as required, including a bare ground conductor.
   5. Individual conductor color coding:
      b. See PART 3 of this Specification Section for additional requirements.
   6. Conform to NFPA 70 Type TC.

C. Control Cable:
   1. Conductor shall be copper with 600 V rated insulation.
   2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   3. Conform to NEMA/ICEA WC 57/S-73-532 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
4. Number of conductors as required, provided with or without bare ground conductor of the same AWG size.
   
a. When a bare ground conductor is not provided, an additional insulated conductor shall be provided and used as the ground conductor (e.g., 6/c No. 14 w/g and 7/c No. 14 are equal).

5. Individual conductor color coding:
   
a. ICEA S-58-679, Method 1, Table E-2.
   
b. See PART 3 of this Specification Section for additional requirements.

6. Conform to NFPA 70 Type TC.

D. Electrical Equipment Control Wire:

1. Conductor shall be copper with 600 V rated insulation.

2. Conductors shall be stranded.

3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.

4. Conform to UL 44 for Type SIS insulation.

5. Conform to UL 83 for Type MTW insulation.

E. Instrumentation Cable:

1. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.

2. Analog cable:
   
a. Tinned copper conductors.
   
b. 300 V or 600 V PVC insulation with PVC jacket.
   
c. Twisted with 100 percent foil shield coverage with drain wire.
   
d. Six (6) twists per foot minimum.
   
   
f. Conform to UL 2250, UL 1581 and NFPA 70 Type ITC.

3. Digital cable:
   
a. As recommended by equipment (e.g., PLC, RTU) manufacturer.
b. Horizontal voice and data cable:
   1) Category 6 per TIA/EIA/ANSI 568.
   2) Cable shall be label-verified.
   3) Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
   4) Conductors: No. 24 AWG solid untinned copper.
   5) Rated CMP per NFPA 70.

c. Conform to NFPA 262 and NFPA 70 Type ITC.

F. Fiber Optic Cables:

1. All multimode fiber optic cable, patch cords and connectors shall be colored orange. SC type connectors shall be used for all fiber optic cable connections. The fiber optic cable shall be multimode 850 nm, supplied by Corning Cable Systems or Approved equal and shall meet or exceed the following minimum specifications:

   a. Each optical fiber shall be sufficiently free of surface imperfections and inclusions to meet the optical and mechanical requirements of the Work and environmental conditions encountered in Greater Los Angeles region.

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

   c. Each optical fiber shall be proof tested by the manufacturer at a minimum of 100 KPSI.

   d. Attenuation shall be ≤ 3.4 dB/Km.

   e. Point discontinuity shall be ≤ 0.2 dB.

   f. Effective modal bandwidth shall be ≥ 220 MHz-Km.

   g. Cladding diameter shall be 125.0 + or – 2.0 µm with a core diameter of 62.5 + or – 3.0 µm, and the coating diameter of 245 + or – 5 µm.

G. Wire Connectors:

1. Twist/screw on type:
   a. Insulated pressure or spring type solderless connector.
b. 600 V rated.

c. Ground conductors: Conform to UL 486C and/or UL 467 when required by local codes.

d. Phase and neutral conductors: Conform to UL 486C.

2. Compression and mechanical screw type:

   a. 600 V rated.
   
   b. Ground conductors: Conform to UL 467.
   
   c. Phase and neutral conductors: Conform to UL 486A.

3. Terminal block type:

   a. High density, screw-post barrier-type with white center marker strip.

   b. 600 V and ampere rating as required, for power circuits.

   c. 600 V, 20 ampere rated for control circuits.

   d. 300 V, 15 ampere rated for instrumentation circuits.

   e. Conform to NEMA ICS 4 and UL 486A.

H. Insulating and Color Coding Tape:

1. Pressure sensitive vinyl.

2. Premium grade.

3. Heat, cold, moisture, and sunlight resistant.

4. Thickness, depending on use conditions: 7, 8.5, or 10 mil.

5. For cold weather or outdoor location, tape must also be all-weather.

6. Color:

   a. Insulating tape: Black.

   b. Color coding tape: Fade-resistant color as specified herein.

7. Comply with UL 510.

I. Pulling Lubricant: Cable manufacturer's standard containing no petroleum or other products which will deteriorate insulation.
PART 3 - EXECUTION

3.01 CONDUCTOR AND INSULATION APPLICATIONS

A. Installation:

1. Permitted Usage of Insulation Types:
   a. Building wire and power and control cable in architectural and non-architectural finished areas.
   b. Building wire and power and control cable in conduit below grade.

2. Type THHN/THWN and THHN/THWN-2:
   a. Building wire and power and control cable No. 8 AWG and smaller in architectural and non-architectural finished areas.

3. Type SIS and MTW:
   a. For the wiring of control equipment within control panels and field wiring of control equipment within switchgear, switchboards, motor control centers.

B. Conductor Size Limitations:

1. Feeder and branch power conductors shall not be smaller than No. 12 AWG unless otherwise indicated on the Drawings.
   a. Solid copper type conductors for No. 12 AWG and No. 10 AWG.

2. Control conductors shall not be smaller than No. 14 AWG unless otherwise indicated on the Drawings.

3. Instrumentation conductors shall not be smaller than No. 18 AWG unless otherwise indicated on the Drawings.

C. Color Code All Wiring as Follows:

1. Building wire:

<table>
<thead>
<tr>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Neutral</th>
<th>Ground</th>
</tr>
</thead>
<tbody>
<tr>
<td>240 V, 208 V</td>
<td>480 V, 240/120 V, 208/120 V</td>
<td>480/277 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>Red *</td>
<td>Blue</td>
<td>White</td>
<td>Green</td>
</tr>
<tr>
<td>Brown</td>
<td>Orange</td>
<td>Yellow</td>
<td>White or Gray</td>
<td>Green</td>
</tr>
</tbody>
</table>
* Orange when it is a high leg of a 120/240 V Delta system.

a. Conductor No. 6 AWG and smaller: Insulated phase, neutral and ground conductors shall be identified by a continuous colored outer finish along its entire length.

b. Conductor larger than No. 6 AWG:

1) Insulated phase and neutral conductors shall be identified by one (1) of the following methods:

a) Continuous colored outer finish along its entire length.

b) 3 IN of colored tape applied at the termination.

2) Insulated grounding conductor shall be identified by one (1) of the following methods:

a) Continuous green outer finish along its entire length.

b) Stripping the insulation from the entire exposed length.

c) Using green tape to cover the entire exposed length.

3) The color coding shall be applied at all accessible locations, including but not limited to: Junction and pull boxes, wireways, manholes and handholes.

2. Power cables ICEA S-58-679, Method 4 with:

a. Phase and neutral conductors identified with 3 IN of colored tape, per the Table herein, applied at the terminations.

b. Ground conductor: Bare.

3. Control cables ICEA S-58-679, Method 1, Table E-2:

a. When a bare ground is not provided, one (1) of the colored insulated conductors shall be re-identified by stripping the insulation from the entire exposed length or using green tape to cover the entire exposed length.
b. When used in power applications the colored insulated conductors used as phase and neutral conductors may have to be re-identified with 3 IN of colored tape, per the Table herein, applied at the terminations.

D. Install all wiring in raceway unless otherwise indicated on the Drawings.

E. Feeder, branch, control and instrumentation circuits shall not be combined in a raceway, cable tray, junction or pull box, except as permitted in the following:

1. Where specifically indicated on the Drawings.

2. Where field conditions dictate and written permission is obtained from the Engineer.

3. Control circuits shall be isolated from feeder and branch power and instrumentation circuits but combining of control circuits is permitted.

   a. The combinations shall comply with the following:
      1) 12 Vdc, 24 Vdc and 48 Vdc may be combined.
      2) 125 Vdc shall be isolated from all other AC and DC circuits.
      3) AC control circuits shall be isolated from all DC circuits.

4. Instrumentation circuits shall be isolated from feeder and branch power and control circuits but combining of instrumentation circuits is permitted.

   a. The combinations shall comply with the following:
      1) Analog signal circuits may be combined.
      2) Digital signal circuits may be combined but isolated from analog signal circuits.

5. Multiple branch circuits for lighting, receptacle and other 120 Vac circuits are allowed to be combined into a common raceway.

   a. Contractor is responsible for making the required adjustments in conductor and raceway size, in accordance with all requirements of the NFPA 70, including but not limited to:
      1) Up sizing conductor size for required ampacity de-ratings for the number of current carrying conductors in the raceway.
      2) The neutral conductors may not be shared.
      3) Up sizing raceway size for the size and quantity of conductors.
F. Ground the drain wire of shielded instrumentation cables at one (1) end only.
   1. The preferred grounding location is at the load (e.g., control panel), not at the source (e.g., field mounted instrument).

G. Splices and terminations for the following circuit types shall be made in the indicated enclosure type using the indicated method.
   1. Feeder and branch power circuits:
      a. Device outlet boxes:
         1) Twist/screw on type connectors.
      b. Junction and pull boxes and wireways:
         1) Twist/screw on type connectors for use on No. 8 and smaller wire.
         2) Compression, mechanical screw or terminal block or terminal strip type connectors for use on No. 6 AWG and larger wire.
      c. Motor terminal boxes:
         1) Twist/screw on type connectors for use on No. 10 AWG and smaller wire.
         2) Insulated mechanical screw type connectors for use on No. 8 AWG and larger wire.
      d. Manholes or handholes:
         1) Twist/screw on type connectors pre-filled with epoxy for use on No. 8 AWG and smaller wire.
         2) Watertight compression or mechanical screw type connectors for use on No. 6 AWG and larger wire.
   2. Control circuits:
      b. Manholes or handholes: Twist/screw on type connectors pre-filled with epoxy.
      c. Control panels and motor control centers: Terminal block or strips provided within the equipment or field installed within the equipment by the Contractor.
3. Instrumentation circuits can be spliced where field conditions dictate and written permission is obtained from the Engineer.
   a. Maintain electrical continuity of the shield when splicing twisted shielded conductors.
   b. Junction and pull boxes: Terminal block type connector.
   c. Control panels and motor control centers: Terminal block or strip provided within the equipment or field installed within the equipment by the Contractor.

4. Non-insulated compression and mechanical screw type connectors shall be insulated with tape or hot or cold shrink type insulation to the insulation level of the conductors.

H. Insulating Tape Usage:
   1. For insulating connections of No. 8 AWG wire and smaller: 7 mil vinyl tape.
   2. For insulating splices and taps of No. 6 AWG wire or larger: 10 mil vinyl tape.
   3. For insulating connections made in cold weather or in outdoor locations: 8.5 mil, all weather vinyl tape.

3.02 FIELD QUALITY CONTROL

A. Testing: Perform each electrical test and visual and mechanical inspection stated in NETA ATS (Acceptance Testing Specifications), Section 7.3.1. Certify compliance with test parameters. See Specification Section 26 08 00.

B. Test Reports: Prepare a written report to record:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Conductors and Cables for electrical and communications systems will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of
values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Conductors and Cables electrical and communications systems furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 26 13 00
CONDUITS, RACEWAYS AND BOXES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Raceways, fittings, boxes, enclosures, and cabinets for electrical and Customer Information System (CIS) communication wiring.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 1 - General Requirements.
   2. Section 01 33 00 - Submittal procedures.
   3. Section 26 05 00 - Basic Electrical Materials and Methods, for supports and anchors.
   4. Section 26 06 00 – Grounding and Bonding
   5. Section 26 07 10 - Seismic Controls for Electrical Work, for seismic restraints and bracing of raceways, boxes, enclosures, and cabinets.
   6. Section 26 14 00 - Wiring Devices, for devices installed in boxes and for floor-box service fittings.
   7. Section 29 00 00 – Summary of Work (CIS)
   8. Section 29 20 20 – Communications Services

1.02 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. FMC: Flexible metal conduit.
C. IMC: Intermediate metal conduit.
D. LFMC: Liquidtight flexible metal conduit.
E. RNC: Rigid nonmetallic conduit.
F. RGS: Rigid Galvanized Steel conduit. Also listed as RMC: Rigid Metallic Conduit.
1.03 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: Show fabrication and installation details of components for raceways, fittings, boxes, enclosures, and cabinets.

C. Shop Drawings: Signed and sealed by a qualified Professional Engineer.

1. Design Calculations: Calculate requirements for selecting seismic restraints.
2. Detail assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

D. Coordination Plans: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

E. Manufacturer Seismic Qualification Certification: Submit certification that enclosures, cabinets, accessories, and components will withstand seismic forces defined in 26 07 10 - Seismic Controls for Electrical Work. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Plans of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
1.04 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   B. Comply with NFPA 70.

1.05 COORDINATION
   A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.01 GENERAL
   A. Where products and manufacturers are listed, make submittals for proposed comparable products and substitutions in accordance with Section 01 60 00 - Product Requirements.

2.02 METAL CONDUIT AND TUBING
   A. Manufacturers: Subject to compliance with requirements, provide products of one of the following, or equal approved as a comparable product:
      1. AFC Cable Systems, Inc., Div. Tyco Electrical and Metal Products.
      2. Anaconda Sealtite brand, Anamet Electrical Inc.
      3. Electri-Flex Co.
      4. Allied Tube and Conduit, Div. Tyco Electrical and Metal Products.
   B. Rigid Galvanized Steel Conduit: NEMA/ANSI C80.1.
   C. Aluminum Rigid Conduit: NEMA/ANSI C80.5.
   D. IMC: NEMA/ANSI C80.6.
G. EMT and Fittings: NEMA/ANSI C80.3.
   1. Fittings: Compression type.

H. FMC: Zinc-coated steel.

I. LFMC: Flexible steel conduit with PVC jacket.

J. Fittings: NEMA/ANSI FB 1; compatible with conduit and tubing materials.

2.03 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following, or equal approved as a comparable product:
   1. Anaconda Sealtite brand, Anamet Electrical Inc.
   2. Arnco Corp.
   3. Cantex Inc.
   5. Condux International.
   7. Electri-Flex Co.
   9. RACO brand, Hubbell Inc.
  10. AFC Cable Systems, Div. Tyco Electrical and Metal Products.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

D. ENT and RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

2.04 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following, or equal approved as a comparable product:
   1. Hoffman Enclosures, div. CHS Controls AB.
   2. Square D brand, Schneider Electric.
3. Wiremold / Legrand.

B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1 or 3R as required to suit installation situation.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E. Wireway Covers: Screw-cover type.

F. Finish: Manufacturer's standard enamel finish.

2.05 NONMETALLIC WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following, or equal approved as a comparable product:

1. Hoffman Enclosures, div. CHS Controls AB.

2. Carlon brand, Lamson & Sessions.

3. Wiremold / Legrand – French.

B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

E. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

2.06 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.

B. Manufacturers: Subject to compliance with requirements, provide products of one of the following, or equal approved as a comparable product:

1. Thomas & Betts Corporation.
2. Wiremold / Legrand.

C. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC compound with matte texture and manufacturer's standard color.

D. Manufacturers: Subject to compliance with requirements, provide products of one of the following, or equal approved as a comparable product:

1. Enduro Systems Inc.
3. Carlon brand, Lamson & Sessions.
4. Panduit Corp.
5. Wiremold / Legrand.

E. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.07 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following, or equal approved as a comparable product:

1. Cooper Crouse-Hinds, div. of Cooper Industries, Inc.
2. Appleton Electric, brand of EGS Electrical Group, joint venture of Emerson and SPX Corporation.
3. Erickson Electrical Equipment Co.
4. Hoffman Enclosures, div. CHS Controls AB.
5. Killark brand, Hubbell Inc.
7. RACO brand, Hubbell Inc.
8. Robroy Industries.
10. Spring City Electrical Manufacturing Co.
12. Wiremold / Legrand.
B. Sheet Metal Outlet and Device Boxes: NEMA/ANSI OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA/ANSI FB 1, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: NEMA/ANSI OS 2.

E. Floor Boxes: Cast metal, fully adjustable, rectangular.

F. Floor Boxes: Nonmetallic, nonadjustable, round.

G. Small Sheet Metal Pull and Junction Boxes: NEMA/ANSI OS 1.

H. Cast-Metal Pull and Junction Boxes: NEMA/ANSI FB 1, cast aluminum with gasketed cover.

I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

J. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.08 FACTORY FINISHES

A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.

B. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard gray paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

A. Outdoors:
   1. Exposed: Rigid galvanized steel or IMC.
   2. Concealed: Rigid galvanized steel or IMC.
3. Underground, Single Run: Concrete encased RNC with reinforcement as indicated on Plans.

4. Underground, Grouped: Concrete encased RNC with reinforcement as indicated on Plans.

5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

6. Boxes and Enclosures: NEMA 250, Type 3R.

B. Indoors:

1. Exposed: Rigid steel below 8 feet AFF; EMT more than 8 FT AFF.

2. Concealed: EMT.

3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.

4. Damp or Wet Locations: Rigid steel conduit.

5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
   
a. Damp or Wet Locations: NEMA 250, Type 4, nonmetallic.

C. Minimum Raceway Size: 3/4 IN trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz.

F. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

G. Do not install aluminum conduits embedded in or in contact with concrete.

3.02 INSTALLATION

A. The Contractor shall conduct field investigations to ensure the locations of existing and new conduits, pull boxes, junction boxes, and equipment prior to developing shop plans.
B. All conduits shall be adequately separated from crossing other utilities per requirements in these specifications and per SCRRA Design Criteria. Per the Design Criteria, outside plant conduits shall be spaced at least 12 inches from other parallel utilities, and at least 6 inch when crossing with other utilities perpendicularly.

C. All outside conduits shall be placed in a trench or buried to a minimum 48 IN below grade to the top of the conduits. Wherever this depth cannot be met, the conduits shall be concrete encased. All conduits shall be installed per requirements in the SCRRA Design Criteria and SCRRA Signaling and Communications Standards.

D. Outside fiber optic cable and conduits, where installed, shall be protected using detectable marking tape placed 6 inch below grade for a length of at least 1,000 feet over the cable installed area to be protected.

E. All required interfaces for connection to the LCD Monitor and FOPP, to the LED Message sign and FOPP, to the EMP, and to speakers shall be installed as per requirements of these Specifications.

F. The Contractor shall install two (2), 1 inch conduits from the nearest electrical pullbox and communications pullbox, respectively, to the location of LCD monitor(s) installation. One conduit shall be used for communications transmission/data transmission to LCD and the requirements for that conduit including pulling cables are described in the CIS section. The other conduit shall carry power to the monitor(s). The fiber shall be interfaced to the monitor through the FOPP as shown in the contract plans.

G. The contractor shall provide electrical and communications cables and conduits for LED message signs as shown in contract documents. The Contractor shall install two (2), 1 inch conduits from the nearest electrical pullbox and communications pullbox, respectively, to the location of LED message sign(s) installation.

H. The Contractor shall extend power from Communications Shelter to the LCD monitor(s). Within each monitor enclosure(s) the Contractor shall provide and install power strip to connect/disconnect power to the Network Media Player (NMP) and the monitor(s). The Contractor shall provide a duplex receptacle; one for the AC and other for the power strip.

I. Complete raceway installation before starting conductor installation.

J. Support raceways as specified in Section 26 05 00 - Basic Electrical Materials and Methods.

K. Install temporary closures to prevent foreign matter from entering raceways.

L. Protect stub-ups from damage where conduits rise through floor slabs.

M. Arrange so that curved portions of bends are not visible above the finished slab.
N. Make bends and offsets so that ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

O. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
   1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

P. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 IN of concrete cover.
   1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
   2. Space raceways laterally to prevent voids in concrete.
   3. Run conduit larger than 1 IN trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   4. Change from nonmetallic tubing to rigid steel conduit before rising above the floor.

Q. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
   1. Run parallel or banked raceways together on common supports.
   2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

R. Join raceways with fittings designed and approved for that purpose and make joints tight.
   1. Use insulating bushings to protect conductors.

S. Terminations:
   1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
   2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so that end bears against wire protection shoulder. Where chase nipples are used, align raceways so that coupling is square to box; tighten chase nipple so that no threads are exposed.
T. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200 LB tensile strength. Leave at least 12 IN of slack at each end of pull wire.

U. Telephone and Signal System Raceways, 2 IN Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 FT and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

V. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2. Where otherwise required by NFPA 70.

W. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 IN above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

X. Flexible Connections: Use maximum of 72 IN of flexible conduit for recessed and semi recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

Y. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.

Z. Set floor boxes level and flush with finished floor surface.

AA. Set floor boxes level. Trim after installation to fit flush with finished floor surface.

BB. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.03 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.
3.04 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Conduits, Raceways, and Boxes for electrical and communications systems will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Enclosures will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

C. Cabinets will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Conduits, Raceways, and Boxes; Enclosures; and Cabinets for electrical and communications systems furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 26 14 00
WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Single and duplex receptacles, ground fault circuit interrupters, and
      integral surge suppression units.
   2. Single and double pole snap switches and dimmer switches.
   3. Device wall plates.
   4. Floor service outlets, poke through assemblies, service poles, and multi
      outlet assemblies.
   5. Accessories required for a complete installation.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 01 33 00 - Submittal Procedures.
   3. Section 01 60 00 - Product Requirements.
   4. Section 26 12 00 - Conductors and Cables – Low Voltage.
   5. Section 26 05 00 - Basic Electrical Materials and Methods.
   6. Section 26 08 00 – Electrical Testing.

1.02 SUBMITTALS

A. Product Data: Technical data for each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process
   used for premarking wall plates.

C. Samples: For each type of device and wall plate specified, in each color
   specified.

D. Field quality control test reports.
1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

2. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 GENERAL

A. Where products and manufacturers are listed, make submittals for proposed comparable products and substitutions in accordance with:

1. Section 01 25 00 – Substitution Procedures.

2. Section 01 33 00 – Submittal Procedures.

3. Section 01 60 00 – Product Requirements,

2.02 MATERIALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved as a substitution:

1. Wiring Devices:
   b. Cooper Wiring Devices.
   d. Leviton Mfg. Company Inc.
   e. Pass & Seymour/Legrand.

2. Multioutlet Assemblies:
   a. Hubbell Incorporated; Wiring Device-Kellems.
   b. Wiremold / Legrand.
B. Receptacles:
   1. Straight Blade Type Receptacles: Comply with NEMA WD 1, NEMA/ANSI WD 6, DSCC W-C-596G, and UL 498.
   2. Straight Blade and Locking Receptacles: Heavy-Duty grade.
   3. Straight Blade Receptacles: Hospital grade.
   4. GFCI Receptacles: Straight blade, non-feed through type, Hospital grade, with integral NEMA/ANSI WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4 IN deep outlet box without an adapter.

C. Switches:
   2. Snap Switches: Heavy Duty grade, quiet type.
   3. Dimmer Switches: Modular, full wave, solid state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.
      a. Control: Continuously adjustable slider; with single-pole or three-way switching to suit connections.
      b. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable rotary knob, toggle switch, or slider; single pole with soft tap or other quiet switch; EMI/RFI filter to eliminate interference; and 5 IN wire connecting leads.
      c. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

D. Wall Plates: Single and combination types to match corresponding wiring devices.
   1. Plate Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: Smooth, high impact thermoplastic 0.04 IN.
   4. Material for Wet Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet locations.
2.03 FINISHES

A. Color:
   1. Wiring Devices Connected to Normal Power System: As selected by Engineer unless otherwise indicated or required by NFPA 70.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install devices and assemblies level, plumb, and square with building lines.
B. Install wall dimmers to achieve indicated rating after derating for ganging.
C. Install unshared neutral conductors on line and load side of dimmers.
D. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
E. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.02 IDENTIFICATION

A. Comply with Section 26 07 50 - Electrical Identification.
   1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.03 CONNECTIONS

A. Ground equipment according to Section 26 06 00 - Grounding and Bonding.
B. Connect wiring according to Section 26 12 00 - Conductors and Cables: Low Voltage.

3.04 FIELD QUALITY CONTROL

A. Perform field tests and inspections and prepare test reports:
   1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
   2. Test GFCI operation with both local and remote fault simulations according to manufacturer’s written instructions.
B. Remove malfunctioning units, replace with new units, and retest as specified above.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 26 28 00

OVERCURRENT AND SHORT CIRCUIT PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Low voltage circuit breakers.
   3. Fuses.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 01 33 00 - Submittal Procedures.
   3. Section 26 05 00 - Basic Electrical Materials and Methods.
   4. Section 26 05 50 - Overcurrent Protective Device Coordination.
   5. Section 26 08 00 – Electrical Testing.

1.02 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

B. National Electrical Manufacturers Association (NEMA):
   1. AB 1, Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures. (Equivalent to UL 489)
C. National Fire Protection Association (NFPA):
   1. 70, National Electrical Code (NEC).

D. Underwriters Laboratories, Inc. (UL):
   3. 1066, Standard for Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.

1.03 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Outline Drawings with dimensions.
      b. Ratings for voltage, amperage and maximum interrupting ratings.
      c. Trip unit functions and adjustments.
      d. Accessories.
      e. Wiring diagrams.
      f. Manufacturer shall provide hard copy time/current characteristic trip curves (and Ip & I²t let through curves for current limiting circuit breakers) for each type of circuit breaker.
   2. Submit with associated switchboard, panelboard or other assembly.

B. Operation and Maintenance Manual.
   a. Include instructions for circuit breaker mounting, trip unit functions and adjustments, trouble shooting, accessories and wiring diagrams.

C. Miscellaneous Submittals:
   1. Reports:
      a. As-left condition of all circuit breakers that have adjustable settings.
      b. Short circuit study report.
      c. Protective coordination study report.
1.04 MAINTENANCE

A. Extra Materials: Provide Owner with 10 percent, but not less than 3, each type and rating installed fuses at completion of Project.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Circuit breakers:
   b. Schneider Electric/Square D.
   c. Siemens.
   d. General Electric.

2. Fuses:
   a. Bussman Manufacturing Division.
   c. Siemens.
   d. General Electric.

2.02 CIRCUIT BREAKERS

A. Molded Case Type:

1. General:
   a. Standards: NEMA AB 1, UL 489.
   b. Unit construction.
   c. Over-center, toggle handle operated.
   d. Quick-make, quick-break, independent of toggle handle operation.
   e. Manual and automatic operation.
   f. All poles open and close simultaneously.
g. Three (3) position handle: On, off and tripped.

h. Molded-in ON and OFF markings on breaker cover.

i. One-, two- or three-pole as indicated on the Drawings.

j. Current and interrupting ratings as indicated on the Drawings.

k. Bolt on type.

2. Thermal magnetic type:

a. Inverse time overload and instantaneous short circuit protection by means of a thermal magnetic element.

b. Frame size 150 amp and below:
   1) Non-interchangeable, non-adjustable thermal magnetic trip units.

c. Frame sizes 225 to 400 amp (trip settings less than 400A):
   1) Interchangeable and adjustable instantaneous thermal magnetic trip units.

d. Ground Fault Circuit Interrupter (GFCI) Listed:
   1) Standard: UL 943.
   2) One- or two-pole as indicated on the Drawings.
   3) Class A ground fault circuit.
   4) Trip on 5 mA ground fault (4-6 mA range).

3. Solid state trip type:

a. Inverse time overload, instantaneous short circuit and ground fault protection by means of a solid state trip element, associated current monitors and flux shunt trip mechanism.

b. Frame size 400 amp to 1200 amp (trip settings between 400 and 1200A):
   1) Standard rating. Provide 100 percent rated where indicated.
   2) Interchangeable current sensor or rating plug.
3) Adjustable long time pick-up setting.
   a) Adjustable from 50 to 100 percent of the current sensor or rating plug.

4) Adjustable short time pick-up setting.

5) Adjustable instantaneous pick-up.

6) Fixed ground fault pick-up, when indicated on the Drawings.

c. Frame size 1600 amp and above:
   1) 100 percent rated.
   2) Interchangeable current sensor or rating plug.
   3) Adjustable long time pick-up setting.
      a) Adjustable from 50 to 100 percent of the current sensor or rating plug.
   4) Adjustable long time delay setting.
   5) Adjustable short time pick-up setting.
   6) Adjustable instantaneous pick-up setting.
   7) Adjustable ground fault pick-up setting, when indicated on the Drawings.
   8) Adjustable ground fault delay setting, when indicated on the Drawings.

2.03 MOTOR CIRCUIT PROTECTOR

A. Adjustable instantaneous short circuit protection by means of a magnetic or solid state trip element.

B. Sized for the connected motor.

2.04 FUSES

A. Provide at locations indicated and as required for supplemental protection.
   1. Fuses: Product of single manufacturer. Trade names and catalog numbers indicated are Bussman.
   2. Fuse Type: Dual-element time-delay.
3. Voltage: 600 V.
4. Ratings: As indicated.
5. Short-circuit interrupting rating: 200,000 Amps RMS symmetrical.
7. UL Class:
8. Main and Feeder Protection:
   a. Where rating of protective device is 600A, provide Bussman KRP-C SP, Class L, current limiting fuses, having interrupting rating of 200,000A RMS.
   b. Where rating of protective device is 600A or less, provide Bussman LIMITRON LPN-RK SP current limiting fuses, having interrupting rating of 200,000A RMS.
9. Motor Protection: Coordinate fuse size with motor to provide motor running protection.
10. Instruction Label: When standard holder type fuses are specified, Class K1 or K5, provide each enclosure where fuses are installed with instruction label fastened at obvious location in enclosure.
   a. Label: Clearly describe type of fuse, voltage rating, and interrupting rating.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Current and interrupting ratings as indicated on the Drawings.
B. Series rated systems not acceptable.
C. Devices shall be ambient temperature compensated.
D. Field settings:
   1. Perform field adjustments of protective devices as required to place equipment in final operating condition. Settings shall be in accordance with approved power system study.
2. Provide certified calibration report for each protective device.

E. Arc Flash Labels:
   1. Provide Arc flash hazard warning label on each piece of electrical equipment as per Arc Flash Hazard Report refer to Section 26 05 50.

F. Circuit Breakers:
   1. Molded case circuit breakers shall incorporate the following, unless indicated otherwise on the Drawings:
      a. Frame sizes 400 amp and less with trip setting less than 400A shall be thermal magnetic type.
      b. Frame sizes 400 amp and larger shall be solid state trip type.
      c. Frame sizes 1000 amp and above shall include integral ground fault protection.

G. Motor circuit protector sized for the connected motor.

3.02 FIELD QUALITY CONTROL

A. Adjustable Circuit Breakers:
   1. Set all circuit breaker adjustable taps as per Protective Device Coordination Study recommended trip settings, refer to Specification Section 26 05 50 except adjust motor circuit protectors per the motor nameplate and NFPA 70 requirements.

B. Ground Fault Protection System:
   1. Single source system:
      a. Coordinated with individual feeder breakers using the residual sensing method.
      b. Main and feeder breakers: Utilize four (4) individual current sensors; the phase sensors are integral to the circuit breaker and the neutral sensor is external to the circuit breaker.

C. Testing:
   1. Acceptance testing: See Specification Section 26 08 00.

PART 4 - MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for
Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidental, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Safety switches.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 01 33 00 - Submittal Procedures.
   3. Section 26 05 00 - Electrical: Basic Requirements.
   4. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

B. Underwriters Laboratories, Inc. (UL):
   1. 98, Enclosed and Dead-Front Switches.

1.03 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Provide a table that associates safety switch model number with connected equipment tag number.
      c. See Specification Section 26 05 00 for additional requirements.
B. Operation and Maintenance Manuals:
   
   1. See Specification Section 01 33 00 for requirements for:
      
      a. The mechanics and administration of the submittal process.
      
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following safety switch manufacturers are acceptable:
   
   
   2. General Electric Company.
   
   
   4. Siemens.
   
   5. Appleton Electric Company.
   
   

B. Submit request for substitution in accordance with Specification Section 01 25 13.

2.02 SAFETY SWITCHES

A. General:
   
   1. Non-fusible or fusible as indicated on the Drawings.
   
   2. Suitable for service entrance when required.
   
   3. NEMA Type HD heavy-duty construction.
   
   4. Switch blades will be fully visible in the OFF position with the enclosure door open.
   
   5. Quick-make/quick-break operating mechanism.
   
   6. Deionizing arc chutes.
7. Manufacture double-break rotary action shaft and switchblade as one (1) common component.

8. Clear line shields to prevent accidental contact with line terminals.

9. Operating handle (except NEMA 7 and NEMA 9 rated enclosures):
   a. Red and easily recognizable.
   b. Padlockable in the OFF position
   c. Interlocked to prevent door from opening when the switch is in the ON position with a defeater mechanism.

B. Ratings:
   1. Horsepower rated of connected motor.
   2. Voltage and amperage: As indicated on the Drawings.
   3. Short circuit withstand:
      a. Non-fused: 10,000A.
      b. Fused: 200,000A.

C. Accessories, when indicated in PART 3 of this Specification Section or on the Drawings:
   1. Neutral kits.
   2. Ground lug kits.
   3. Auxiliary contact kits with 1 N.O. and 1 N.C. contact.

D. Enclosures:
   1. NEMA 1 rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
      b. With or without knockouts, hinged and lockable door.
   2. NEMA 3R rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
      b. With or without knockouts, hinged and lockable door.
3. **NEMA 4 rated:**
   a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.

4. **NEMA 4X rated (metallic):**
   a. Body and cover: Type 304 or 316 stainless steel.
   b. No knockouts, external mounting flanges, hinged and gasketed door.

5. **NEMA 4X rated (non-metallic):**
   b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.

6. **NEMA 7 and NEMA 9 rated:**
   a. Cast gray iron alloy or copper-free aluminum with manufacturers standard finish.
   b. Drilled and tapped openings or tapered threaded hub.
   c. Gasketed cover bolted-down with stainless steel bolts.
   d. External mounting flanges.
   e. Operating handle padlockable in the OFF position.

7. **NEMA 12 rated:**
   a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   b. No knockouts, external mounting flanges, hinged and gasketed door.

**E. Overcurrent and short circuit protective devices:**

1. Fuses.
2. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.
F. Standards: NEMA KS 1, UL 98.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install as indicated and in accordance with manufacturer’s instructions and recommendations.

B. Install switches adjacent to the equipment they are intended to serve unless otherwise indicated on the Drawings.

C. Provide auxiliary contact kit on local safety switches for motors being controlled by a variable frequency drive.
   1. The VFD is to be disabled with the switch is in the open position.

D. Permitted uses of NEMA 1 enclosure:
   1. Surface or flush mounted in areas designated dry in architecturally finished areas.

E. Permitted uses of NEMA 3R enclosure:
   1. Surface mounted in exterior location for HVAC equipment only.

F. Permitted uses of NEMA 4 enclosure:
   1. Surface mounted in areas designated as wet.

G. Permitted uses of NEMA 4X metallic enclosure:
   1. Surface mounted in areas designated as wet and/or corrosive.

H. Permitted uses of NEMA 4X non-metallic enclosure:
   1. Surface mounted in areas designated as corrosive.
   2. Surface mounted in areas designated as highly corrosive.

I. Permitted uses of NEMA 7 enclosure:
   1. Surface mounted in areas designated as Class I hazardous.
   2. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

J. Permitted uses of NEMA 9 enclosure:
   1. Surface mounted in areas designated as Class II hazardous.
2. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

K. Permitted uses of NEMA 12 enclosure:

1. Surface mounted in areas designated as dry in non-architecturally finished areas.

PART 4 - MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 26 28 90
TRANSIENT VOLTAGE SUPPRESSION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Transient voltage surge suppressors for low-voltage power, control, and communication equipment.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 01 60 00 - Product Requirements.
   2. Section 01 78 39 - Project Record Documents.
   3. Section 26 14 00 - Wiring Devices, for devices with integral transient voltage surge suppressors.
   4. Section 26 44 20 - Service Pedestals and Panelboards, for factory-installed transient voltage surge suppressors.

1.02 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

B. Product Certificates: Signed by manufacturers of transient voltage suppression devices, certifying that products furnished comply with the following testing and labeling requirements:
   1. UL 1283 certification.
   2. UL 1449 listing and classification.

C. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Failed test results and corrective action taken to achieve requirements.

D. Maintenance Data: For transient voltage suppression devices to include in maintenance manuals specified in Division 01.
E. Warranties: Special warranties specified in this Section.

1.03 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.

C. Product Options: Drawings indicate size, dimensional requirements, and electrical performance of suppressors and are based on the specific system indicated. Other manufacturers' products complying with requirements may be considered. Refer to Section 01 60 00 - Product Requirements.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


F. NEMA Compliance: Comply with NEMA LS 1, Low Voltage Surge Protective Devices.

G. UL Compliance: Comply with UL 1283, Electromagnetic Interference Filters, and UL 1449, Transient Voltage Surge Suppressors.

1.04 PROJECT CONDITIONS

A. Placing into Service: Do not energize or connect panelboards, control terminals or data terminals to their sources until the surge protective devices are installed and connected.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by AUTHORITY or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Engineer not less than two days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Engineer’s written permission.
Section 26 28 90

C. Service Conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 120 DegF.
3. Humidity: 0 to 85 percent, non-condensing.
4. Altitude: Less than 20,000 FT above sea level.

1.05 COORDINATION

A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.

1.06 WARRANTY

A. General Warranty: Special warranties specified in this Article shall not deprive Authority of other rights Authority may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of Substantial Completion.

C. Special Warranty for Plug-in Cord-Connected Surge Suppressors: Written warranty, executed by manufacturer agreeing to repair or replace electronic equipment connected to circuits protected by surge suppressors.

1.07 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.01 GENERAL

A. Where products and manufacturers are listed, make submittals for proposed comparable products and substitutions in accordance with Section 01 60 00 - Product Requirements.
2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved as a comparable product:

1. Manufacturers of a Broad Line of Suppressors:
   a. Advanced Protection Technologies, Inc.
   b. Atlantic Scientific Corp.
   c. Current Technology, brand of Danaher Power Solutions, subsidiary of Danaher Corp.
   d. Cutler-Hammer brand, Eaton Electrical Inc.
   e. Innovative Technology brand, Eaton Electrical Inc.
   f. Intermatic, Inc.
   g. LEA International, a Smiths Group company.
   h. Leviton Manufacturing Co. Inc.
   i. Liebert Corp., an Emerson Network Power company, div Emerson.
   j. Northern Technologies Corp.
   k. Siemens Energy & Automation.
   l. Square D, brand of Schneider Electric.

2. Manufacturers of Category A and Telephone/Data Line Suppressors:
   a. MCG Surge Protection.
   b. Telebyte, Inc.

2.03 SERVICE ENTRANCE SUPPRESSORS

A. Surge Protective Device Description: Non-modular type with the following features and accessories:

1. LED indicator lights for power and protection status.

2. Audible alarm, with silencing switch, to indicate when protection has failed.
3. One set of dry contacts rated at 5 A, 250 Vac, for remote monitoring of protection status.

B. Surge Protective Device Description: Modular design with field-replaceable modules and the following features and accessories:

1. Fuses, rated at 200 kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. Arrangement with copper busbars and for bolted connections to phase buses, neutral bus, and ground bus.
7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
8. Red and green LED indicator lights for power and protection status.
9. Audible alarm, with silencing switch, to indicate when protection has failed.
10. One set of dry contacts rated at 5 A and 250 Vac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
11. Surge-event operations counter.


D. Connection Means: Permanently wired.

E. Protection modes and UL 1449 clamping voltage for grounded wye circuits with voltages of 480Y/277; 208Y/120; 3 PH, four-wire circuits, shall be as follows:

1. Line to Neutral: 800 V for 480Y/277; 400 V for 208Y/120.
2. Line to Ground: 800 V for 480Y/277; 400 V for 208Y/120.
3. Neutral to Ground: 800 V for 480Y/277; 400 V for 208Y/120.

F. Protection modes and UL 1449 clamping voltage for 240/120 V, single phase, three-wire circuits, shall be as follows:

1. Line to Neutral: 400 V.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

G. Protection modes and UL 1449 clamping voltage for 240/120 V, 3 PH, four-wire circuits, with high leg shall be as follows:

1. Line to Neutral: 400 V, 800 V from high leg.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

2.04 PANELBOARD SUPPRESSORS

A. Surge Protective Device Description: Non-modular type with the following features and accessories:

1. LED indicator lights for power and protection status.
2. Audible alarm, with silencing switch, to indicate when protection has failed.
3. One set of dry contacts rated at 5 A, 250 Vac, for remote monitoring of protection status.

B. Surge Protective Device Description: Modular design with field-replaceable modules and the following features and accessories:

1. Fuses, rated at 200 kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
7. Red and green LED indicator lights for power and protection status.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. One set of dry contacts rated at 5 A, 250 Vac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
10. Surge-event operations counter.

C. Peak Single-Impulse Surge Current Rating: 120 kA per phase.
D. Protection modes and UL 1449 clamping voltage for grounded wye circuits with voltages of 480Y/277 or 208Y/120; 3-phase, 4-wire circuits, shall be as follows:

1. Line to Neutral: 800 V for 480Y/277; 400 V for 208Y/120.
2. Line to Ground: 800 V for 480Y/277; 400 V for 208Y/120.
3. Neutral to Ground: 800 V for 480Y/277; 400 V for 208Y/120.

E. Protection modes and UL 1449 clamping voltage for 240/120 V, single phase, three-wire circuits, shall be as follows:

1. Line to Neutral: 400 V.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

F. Protection modes and UL 1449 clamping voltage for 240/120 V, 3 PH, four-wire circuits, with high leg shall be as follows:

1. Line to Neutral: 400 V, 800 V from high leg.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

2.05 AUXILIARY PANEL SUPPRESSORS

A. Surge Protective Device Description: Unit type, panel-mounted design with the following features and accessories:

1. LED indicator lights for power and protection status.
2. Audible alarm, with silencing switch, to indicate when protection has failed.
3. One set of dry contacts rated at 5 A, 250 Vac, for remote monitoring of protection status.
4. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
5. Red and green LED indicator lights for power and protection status.
6. Audible alarm, with silencing switch, to indicate when protection has failed.


C. Protection modes and UL 1449 clamping voltage for grounded wye circuits with voltages of 480Y/277; 208Y/120; 3 PH, four-wire circuits, shall be as follows:
1. Line to Neutral: 800 V for 480Y/277; 400 V for 208Y/120.
2. Line to Ground: 800 V for 480Y/277; 400 V for 208Y/120.
3. Neutral to Ground: 800 V for 480Y/277; 400 V for 208Y/120.

D. Protection modes and UL 1449 clamping voltage for 240/120 V, single phase, three-wire circuits, shall be as follows:
   1. Line to Neutral: 400 V.
   2. Line to Ground: 400 V.
   3. Neutral to Ground: 400 V.

E. Protection modes and UL 1449 clamping voltage for 240/120 V, 3 PH, four-wire circuits, with high leg shall be as follows:
   1. Line to Neutral: 400 V, 800 V from high leg.
   2. Line to Ground: 400 V.
   3. Neutral to Ground: 400 V.

2.06 PLUG-IN SURGE SUPPRESSORS

A. Description: Non-modular, plug-in suppressors with at least four 15 A, 120 Vac, NEMA WD 6, Configuration 15-15R receptacles, suitable to plug into a NEMA WD 6, Configuration 15-15R receptacle; with the following features and accessories:
   1. LED indicator lights for power and protection status.
   2. LED indicator lights for reverse polarity and open outlet ground.
   3. Circuit breaker and thermal fusing. When protection is lost, circuit opens and cannot be reset.
   4. Circuit breaker and thermal fusing. Unit continues to supply power if protection is lost.
   5. Close-coupled direct plug-in line cord.
   6. Rocker-type on-off switch, illuminated when in the on position.
   7. One RJ11/12C telephone line protector, suitable for modem connection. Maximum clamping voltage 220 peak on pins No. 3 and 4.

B. Peak Single-Impulse Surge Current Rating: 26 kA per phase.

C. Protection modes and UL 1449 clamping voltage shall be as follows:
1. Line to Neutral: 475 V.
2. Line to Ground: 475 V.
3. Neutral to Ground: 475 V.

2.07 CONTROL AND DATA TERMINALS

A. Protectors for copper control and data conductors entering the building from the outside shall be as recommended by the manufacturer for the type of line being protected.

2.08 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.01 INSTALLATION OF SURGE PROTECTIVE DEVICES

A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install devices for panelboard and auxiliary panels with conductors between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide multipole, 15-A circuit breaker as a dedicated disconnect for the suppressor, unless otherwise indicated.

3.02 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.03 FIELD QUALITY CONTROL

A. Testing: SCRRRA will engage a qualified testing agency to perform the following field quality-control testing:

1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with requirements.

2. Complete startup checks according to manufacturer's written instructions.

3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.19. Certify compliance with test parameters.
B. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
   1. Verify that electrical wiring installation complies with manufacturer's installation requirements.

### 3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train AUTHORITY's maintenance personnel to adjust, operate, and maintain surge protective devices.
   1. Train Authority's maintenance personnel on procedures and schedules for maintaining suppressors.
   2. Review data in maintenance manuals. Refer to Section 01 78 39 - Project Record Documents.
   3. Schedule training with Authority, through Engineer, with at least seven days' advance notice.

### PART 4 - MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
1.01 SUMMARY

A. Section Includes:
1. Individually mounted enclosed switches and circuit breakers, rated 600 V and less, used for disconnecting and protection functions.
2. Accessories required for a complete installation.
3. Device Short Circuit withstand capability as recommended by Short Circuit Study and device trip setting as per Protective Device Coordination Study recommended settings specified in Section 26 05 50.

B. Related Specification Sections include but are not necessarily limited to:
1. Division 01 - General Requirements.
2. Section 01 33 00 - Submittal Procedures.
3. Section 01 60 00 - Product Requirements.
4. Section 26 05 00 - Basic Electrical Materials and Methods.
5. Section 26 08 00 – Electrical Testing.

1.02 SUBMITTALS

A. Product Data: Technical data for each type of switch and circuit breaker indicated.

B. Shop Drawings: Include wiring diagrams for shunt-tripped circuit breakers.

C. Field quality control test reports.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Comply with NFPA 70.
B. Source Limitations: Obtain switches and circuit breakers through one source from a single manufacturer.

PART 2 - PRODUCTS

2.01 GENERAL

A. Where products and manufacturers are listed, make submittals for proposed comparable products and substitutions in accordance with Section 01 60 00 - Product Requirements.

2.02 MATERIALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved as a comparable product:

1. ABB Group.
2. Cutler Hammer brand, Eaton Corporation.
3. GE, Electrical Distribution div.
5. Square D brand, Schneider Electric.

B. Enclosed Switches:

1. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle, interlocked with cover.
2. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, with clips to accommodate specified fuses, and lockable handle, interlocked with cover.

C. Enclosed Circuit Breakers:

1. Molded Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
   b. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field adjustable trip setting.
   c. Current Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
d. GFCI Circuit Breakers: Single and two pole configurations with 5 mA trip sensitivity.

2. Molded Case Circuit Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
   a. Lugs: Suitable for number, size, trip ratings, and material of conductors.
   b. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air conditioning, and refrigerating equipment.
   c. Ground Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time delay settings, push to test feature, and ground-fault indicator.
   d. Shunt Trip: 120-V trip coil energized from separate circuit, capable of tripping at 75 percent of rated voltage.

D. Enclosures:
   1. Listed for environmental conditions of installed locations, including:
      a. Outdoor Locations: NEMA 250, Type 3R.
      b. Wet or Damp Indoor Locations: NEMA 250, Type 4.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Temporary Provisions: Remove temporary lifting provisions and blocking of moving parts.

B. Identify components; provide warning signs as specified in Section 26 07 50 - Electrical Identification.

3.02 FIELD QUALITY CONTROL

A. Testing: After installing disconnect switches and circuit breakers and after electrical circuits have been energized, demonstrate product capability and compliance with requirements.
B. Inspections and Tests for Switches and Circuit Breakers: Make internal and external inspections and perform tests, including the following:

1. Inspect for freedom from physical damage, proper unit rating, mechanical condition, enclosure integrity, cover operation, unit anchorage, clearances, and tightness of electrical connections. If a loose electrical connection is observed on any unit, check each electrical connection for each switch and circuit breaker with a torque wrench for compliance with manufacturer's torquing instructions.

2. Test insulation resistance of each pole, phase to phase, and phase to ground, following manufacturer's written instructions. Test insulation resistance of shunt trip circuits. Use 500-V minimum test voltage for units and circuits rated up to 250 V, 1000-V minimum test voltage for units rated more than 250 V. Measured insulation resistance must be 25 megohms, minimum, for switches rated up to 250 V, and 100 megohms, minimum, for switches rated more than 250 V.

3. Test cover and other interlocks and interlock release devices for proper operation.

C. Additional Inspections and Tests for Switches. Include the following:

1. Inspect for proper rating and fuse provisions.

2. Check adequacy and integrity of fuse holders by removing and installing fuses.

3. Check integrity of phase barriers.

4. Inspect blade alignment visually while operating switch to observe adequacy of blade pressure.

D. Additional Inspections and Tests for Circuit Breakers:

1. Inspect for proper frame, trip, and fault current interrupting rating.

2. Test shunt trip devices, circuits, and actuating components for proper operation.

E. Correct defective and malfunctioning units on site, where possible, and re-inspect and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

PART 4 - MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all
work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 26 42 00
ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. AC general-purpose controllers rated 600 V and less that are supplied as enclosed units.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 01 33 00 - Submittal Procedures.
   3. Section 01 60 00 - Product Requirements.
   4. Section 26 05 00 - Basic Electrical Materials and Methods.
   5. Section 26 07 10 – Seismic Controls for Electrical Work.
   6. Section 26 08 00 – Electrical Testing.
   7. Section 26 28 00 - Overcurrent Protective Devices.

1.02 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each enclosed controller.
   1. Dimensioned plans, elevations, Sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Enclosure types and details.
      b. Nameplate legends.
      c. Short-circuit withstand rating of integrated unit.
d. UL listing for series rating of overcurrent protective devices in combination controllers.

e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.


C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Manufacturer Seismic Qualification Certification: Certification that enclosed controllers, accessories, and components will withstand seismic forces defined in Section 26 07 10 - Seismic Controls for Electrical Work. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

F. Operation and Maintenance Data: For enclosed controllers and components to include in operation and maintenance manuals. Include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicted, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled, as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 70.

F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, including clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subjected to weather, cover enclosed controllers to protect from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.05 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7.

C. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

D. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.
1.06 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spare Fuses: Furnish one spare for every three installed, but not less than one set of three of each type and rating.

2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.01 GENERAL

A. Where products and manufacturers are listed, make submittals for proposed comparable products and substitutions in accordance with Section 01 60 00 - Product Requirements.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved as a comparable product:

1. Manual and Magnetic Enclosed Controllers:
   a. ABB.
   c. GE, Electrical Distribution div.
   d. Allen-Bradley brand, Rockwell Automation.
   e. Furnas brand, Siemens Energy and Automation.
   f. Square D brand, Schneider Electric.

2.03 MANUAL ENCLOSED CONTROLLERS

A. Description: NEMA ICS 2, general purpose, Class A, with toggle action and overload element.

2.04 MAGNETIC ENCLOSED CONTROLLERS

A. Description: NEMA ICS 2, Class A, full voltage, non-reversing, across the line, unless otherwise indicated.
B. Control Circuit: 120 V; obtained from integral control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

C. Combination Controller: Factory-assembled combination controller and disconnect switch.
   1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a nationally recognized testing laboratory.

D. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 10 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.

2.05 ENCLOSURES

A. Description: Flush- or surface-mounted cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
   1. Outdoor Locations: NEMA 250, Type 3R.
   2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
   3. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.06 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, as indicated on Drawings.


C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.
E. Other Control devices as indicated on Drawings.

2.07 FACTORY FINISH

A. Finish: Manufacturer's standard grey paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.03 INSTALLATION

A. See Section 26 05 00 - Basic Electrical Materials and Methods, for general installation requirements.

B. For control equipment on walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 26 05 00 - Basic Electrical Materials and Methods.

C. Install freestanding equipment on concrete bases complying with Section 03 30 00 - Cast-in-Place Concrete.

D. Comply with mounting and anchoring requirements specified in Section 20 07 10, - Seismic Controls for Electrical Work.

E. Enclosed Controller Fuses: Install fuses in each fusible switch.

3.04 IDENTIFICATION

A. Identify enclosed controller components and control wiring according to Section 26 05 00 - Basic Electrical Materials and Methods.
3.05 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Section 26 12 00 - Conductors and Cables – Low Voltage.

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only manual- and automatic- control devices that have no safety functions when switch is in hand position.

3.06 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections.

B. Drawings indicate general arrangement of conduit, fittings, and specialties.

C. Ground equipment.

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.07 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each enclosed controller bus component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Testing: AUTHORITY will engage an independent testing agency to perform the following field quality-control testing:
   1. Perform each electrical test and visual and mechanical inspection indicated in NETA ATS, Sections 7.5, 7.6, and 7.16.
   2. Certify compliance with test parameters.
   3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Test Reports: Prepare a written report to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.08 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.09 CLEANING

A. Clean enclosed controllers internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

PART 4 - MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 26 44 10
SWITCHBOARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Service and distribution switchboards rated 600 V and less.
2. Accessories required for a complete installation.

B. Section applies to service entrance rated outdoor distribution switchboard “DTPB”.

C. Related Specification Sections include but are not necessarily limited to:
1. Division 01 - General Requirements.
2. Section 26 05 00 - Basic Electrical Materials and Methods.
3. Section 26 05 50 - Overcurrent Protective Device Coordination.
4. Section 26 06 00 - Grounding and Bonding.
5. Section 26 07 10 - Seismic Controls for Electrical Work.
6. Section 26 07 50 - Electrical Identification.
7. Section 26 08 00 - Electrical Testing.
8. Section 26 12 00 - Conductors and Cables: Low Voltage.
9. Section 26 28 00 - Overcurrent Protective Devices.
10. Section 26 28 90 - Transient Voltage Suppression.

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
2. PB 2, Deadfront Distribution Switchboards.
B. Underwriters Laboratories, Inc. (UL):
   1. 891, Standard for Safety Dead-Front Switchboards.

1.03 SUBMITTALS

A. Product Data: For each type of switchboard, and switchboard component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each switchboard and related equipment. Include the following:

   1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

   2. Bus configuration, current, and voltage ratings.


   4. Features, characteristics, ratings, and factory settings of individual Overcurrent protective devices and auxiliary components.


C. Field quality control testing reports.

1.04 QUALITY ASSURANCE

A. Verify the space required for the switchboard is equal to or less than the space allocated

B. Regulatory Requirements:

   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

   2. Comply with NEMA PB 2 and UL 891.

   3. Comply with NFPA 70.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to SANBAG.
PART 2 - PRODUCTS

2.01 GENERAL

A. Where products and manufacturers are listed, make submittals for comparable products and substitutions in accordance with Section 26 60 00 - Product Requirements.

2.02 MATERIALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved as a comparable product:

1. ABB Group.
5. Square D brand, Schneider Electric.

B. Manufactured Units:

1. NEMA 3R rated weatherproof enclosure:
2. Non-walk-in type with sloping roof downward toward rear.
3. Thermostatically controlled space heaters to minimize internal condensation.
4. Rodent barrier.
5. Seismic qualified.
6. Power for heater derived internal to the switchboard.
7. Switchboard Configuration: Front, side and rear accessible, with fixed, individually mounted main device, panel mounted branches, and adjacent vertical sections front aligned.
8. Suitable for use as service entrance when not more than 6 main disconnecting means are provided.
9. EUSERC terminals per Southern California Edison California.
10. Provide Incoming Utility Metering Compartment as per utility requirements.
11. Means to padlock all main and feeder devices in the open position.
12. Buses and Bus Connections: Service entrance rated three phase, four wire, and copper ground bus unless otherwise indicated. Materials and Features as follows:

13. Main-Bus Continuous Rating: As indicated on Drawings.


15. Connections to Main and Feeder Protective Devices:

16. Use copper for protective device line and load connections.

17. Enclosure Finish: Factory applied finish in manufacturer's standard gray color over a rust-inhibiting primer on treated metal surface.

18. Barriers: Between adjacent switchboard sections.


20. Pull Box on Top of Switchboard: Provide adequate ventilation to maintain temperature in pull box within same limits as switchboard.

21. Cable Supports: Arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

22. Load Terminals: Insulated, rigidly braced, silver plated, copper runback bus extensions equipped with pressure connectors for outgoing circuit conductors.

23. Ground Bus: 1/4 IN x 2 IN minimum size, drawn temper copper of 98 percent conductivity, continuous over length of switchboard and solidly grounded to each vertical section structure. Bus joints connected using through bolts and conical spring-type washers for maximum conductivity.

24. Equipped with pressure connectors for feeder and branch circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

25. Contact Surfaces of Buses: Silver plated.

26. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.

27. Neutral Buses: 100 percent of the ampacity of the phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables.
28. Future Devices: Equip positions with mounting brackets, supports, bus connections, load terminals, and appurtenances rated at maximum capacity available for future unit.

29. Bus Bar Insulation: Flame retardant, 105 DegC minimum tape wrapping, or flame retardant, sprayed on insulation of same temperature rating, factory applied to individual bus bars.

30. Surge Protective Device: Integ rall mounted, see Specification Section 26 28 90

C. Overcurrent Protective Devices:

1. Molded-Case Circuit Breakers: NEMA AB 1, with standard frame sizes, trip ratings, and number of poles, and interrupting capacity to meet available fault currents.


3. Adjustable Instantaneous Trip Circuit Breakers: Magnetic trip element with front-mounted, field adjustable trip setting.

4. Electronic Trip Unit Circuit Breakers: Required for circuit breaker frame size 400 A and larger. RMS sensing; field replaceable rating plug; with field adjustable settings:

5. Instantaneous trip.


7. Long and short term time adjustments.

8. Ground fault pickup level, time delay, and I2t response.

9. Current Limiting Circuit Breakers: Frame sizes 400 A and smaller; let through ratings less than NEMA FU 1, RK-5.

10. Molded Case Circuit Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

11. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air conditioning, and refrigerating equipment.

12. Ground Fault Protection: Integ rall mounted sensor, relay, and trip unit with adjustable pickup and time delay settings, push to test feature, and ground fault indicator.
13. Shunt Trip: 120-V trip coil energized from separate circuit, capable of tripping at 75 percent of rated voltage.

14. Auxiliary Switch: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit breaker contacts.

15. Key Interlock Kit: Furnish where indicated on Drawings. Externally mounted to prohibit circuit breaker operation; key shall be removable only when circuit breaker is in off position.

D. Instrumentation:

1. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:

2. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.

3. Current Transformers: Provide ratios as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.

4. Multifunction Digital Metering Monitor: Microprocessor based unit suitable for three or four wire systems and with features:

5. Switch selectable digital display of the following values with maximum accuracy tolerances as indicated:

   1) Phase Currents, Each Phase: ±1 percent.

   2) Phase to Phase Voltages, Three Phase: ±1 percent.

   3) Phase to Neutral Voltages, Three Phase: ±1 percent.

   4) Megawatts: ±2 percent.

   5) Megavars: ±2 percent.

   6) Power Factor: ±2 percent.

   7) Frequency: ±0.5 percent.

   8) Megawatt Demand: ±2 percent; demand interval programmable from 5 to 60 minutes.

   9) Accumulated Energy, Megawatt Hours: ±2 percent. Accumulated values unaffected by power outages up to 72 HRS.

6. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
E. Control Power:

1. Control Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.

2. Control Circuits: 120 V, supplied through secondary disconnecting devices from control power transformer.


4. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

F. Accessory Components:

1. Accessory Set: Tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

2. Portable Test Set: To test functions of solid state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install switchboards and accessories according to NEMA/ANSI PB 2.1.

B. Outdoor location:

1. NEMA 3R enclosure.

2. Install on concrete pad 4 IN nominal thickness, align front of switchboard with top edge of pad chamfer and securely fasten to pad.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
3.02 IDENTIFICATION

A. Identify field installed conductors, interconnecting wiring, and components; provide warning signs as specified.

B. Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated plastic nameplate mounted with corrosion resistant screws.

3.03 FIELD QUALITY CONTROL

A. Prepare for acceptance tests:
   1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. SANBAG will engage an independent agency to conduct field quality control tests.

C. When indicated in the plans provide Ground Fault Protection System:
   1. Single source system:
   2. Main breaker using the residual sensing method system.

D. Main and feeder breakers: Utilize four (4) individual current sensors; the phase sensors are integral to the circuit breaker and the neutral sensor is external to the circuit breaker Testing: After installing switchboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
   1. Procedures: Perform each electrical test and visual and mechanical inspection indicated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front and rear panels so that joints and connections are accessible to portable scanner.
   1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switchboards checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. Report test results in writing.

3.04 ADJUSTING

A. Set field adjustable switches and circuit breaker trip ranges as per Section 26 05 50 - Overcurrent Protective Device Coordination.

PART 4 - MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as

END OF SECTION
SECTION 26 44 20

SERVICE PEDESTALS AND PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Electrical Service Cabinet:
   a. Pulling Section.
   b. Metering Compartment.
   d. Customer Main Disconnect and Distribution Equipment.

2. Service Pedestal at the Station:
   a. Section 1 – Distribution Switchboard “DTPB”. Refer to Section 26 44 10 Switchboards.
   b. Section 2 – “TPH” for panelboard TPH and lighting controls.
   c. Section 3 – “TXB1” for step down transformer TXB1.
   d. Section 4 – “TPL” for panelboard TPL and lighting controls.

3. Distribution and branch circuit panelboards.

4. Accessories required for a complete installation.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 01 - General Requirements.
2. Section 26 05 00 - Basic Electrical Materials and Methods.
3. Section 26 06 00 - Grounding and Bonding.
4. Section 26 07 10 - Seismic Controls for Electrical Work.
5. Section 26 07 50 - Electrical Identification
6. Section 26 08 00 - Electrical Testing.
7. Section 26 12 00 - Conductors and Cables – Low Voltage.
8. Section 26 28 16 – Safety Switches
9. Section 26 46 00 - Dry-Type Transformers.
10. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.
11. Section 26 28 90 - Transient Voltage Suppression.
12. Section 26 50 00 - Interior and Exterior Lighting.

1.02 SUBMITTALS

A. Product Data: Manufacturer’s technical data for each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each electric cabinet, lighting control cabinet and panelboard:

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following data:

   a. Enclosure types and details for types other than NEMA 250, Type 1.
   b. Bus configuration, and current, and voltage ratings.
   c. Short circuit current rating of panelboards and overcurrent protective devices.
   d. Listing for series rating of installed devices.
   e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
   f. Withstand rating per short circuit and coordination study.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

D. Field Quality Control Test Reports.

1.03 QUALITY ASSURANCE

A. Definitions:
1. Industrial Control Panel: An assembly of two or more components consisting of one of the following:
   a. Power components only, such as circuit breakers, fused disconnect switches, overload relays, motor controllers and contactors.
   b. Control circuit components only, such as pushbuttons, pilot lights, selector switches, timer switches, control relays
   c. A combination of power and control circuit components.
   d. These components, with associated wiring and terminals, are mounted on or contained within an enclosure or mounted on a subpanel. The industrial control panel does not include the controlled equipment.

B. Regulatory Requirements for Service Pedestal listed:

C. Regulatory Requirements for Panelboards:
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   2. Comply with NEMA PB 1.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved as a comparable product:
   1. ABB Group.
   5. Square D brand, Schneider Electric.
B. For electric service pedestal and lighting control cabinets custom engineered, approved manufacturers:

1. Electrical Services Limited (ESL).
2. Tesco Electric.

C. Components:

1. Enclosures: Flush and surface mounted cabinets. NEMA PB 1, Type 1, suitable for environmental conditions at installed location.
   a. Outdoor Locations: NEMA 250, Type 3R.
   b. Wet or Damp Indoor Locations: NEMA 250, Type 4.
2. Front: Secured to box with concealed trim clamps. For surface mounted fronts, match box dimensions; for flush mounted fronts, overlap box.
3. Finish: Enamel finish over corrosion resistant treatment or primer coat.
6. Equipment Ground Bus: Adequate for feeder and branch circuit equipment ground conductors; bonded to box.
7. Panelboard Short Circuit Rating: Per study; refer to Section 26 05 50 - Overcurrent Protective Device Coordination.
8. Fully rated to interrupt symmetrical short circuit current available at terminals, as indicated on Drawings.
10. Skirt for Surface Mounted Panelboards: Same thickness and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
11. Feed through Lugs: Locate at opposite end of bus from incoming lugs or main device.

D. Lighting and Appliance Branch Circuit Panelboards:
1. Branch Overcurrent Protective Devices: Bolt on circuit breakers, replaceable without disturbing adjacent units.

2. Doors: Front mounted with concealed hinges; secured with flush latch with tumbler lock; keyed alike.

E. Distribution Panelboards:

1. Doors: Front mounted, and secured with vault type latch with tumbler lock; keyed alike.

2. Provide branch overcurrent protective of one of the following:
   a. For Circuit Breaker Frame Sizes 125 A and Smaller: Bolt on circuit breakers.
   b. For Circuit Breaker Frame Sizes Larger Than 125 A: Bolt on circuit breakers; plug in circuit breakers where individual positive-locking device requires mechanical release for removal.

F. Overcurrent Protective Devices:

1. Molded Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents without use of fuses.
   b. GFCI Circuit Breakers: Single and two pole configurations with 5 mA trip sensitivity.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air conditioning, and refrigerating equipment.
   d. Shunt Trip (Where indicated on Drawings): 120-V trip coil energized from separate circuit, capable of tripping at 75 percent of rated voltage.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1. Install flush unless otherwise indicated.

B. Mounting Heights: Top of trim 74 IN above finished floor, unless otherwise indicated.
C. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

D. Install filler plates in unused protective device spaces.

E. Provision for Future Circuits at Flush Panelboards: Stub four 1 IN empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1 IN empty conduits into raised floor space or below slab not on grade.

F. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.02 IDENTIFICATION

A. Identify field installed conductors, interconnecting wiring, and components; provide warning signs as specified.

B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated plastic nameplate mounted with corrosion resistant screws.

C. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

3.03 FIELD QUALITY CONTROL

A. Testing and Inspection: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

   1. Procedures: Perform each electrical test and visual and mechanical inspection indicated in NETA ATS, Section 7.6 for molded case circuit breakers.

   2. Test insulation resistance of panelboard bus with a megohmmeter, and ground continuity of cabinet and ground bus. Reject buses with insulation resistance less than 2 megohms.

   3. Correct defective and malfunctioning units on site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

B. Balancing Loads: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes as follows:

   1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24 HR services such as fax machines and on line data-processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record load readings before and after changes and submit test records.

4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

C. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each electrical cabinet, service pedestal and panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Record of Infrared Scanning: Prepare certified report identifying electrical cabinets, service pedestals and panelboards checked and describing scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 26 46 00

DRY TYPE TRANSFORMERS (600 V AND LESS)

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Dry type transformers rated 600V and less, with capacities up to 1000 kVA.
   2. Distribution transformers.
   3. Control and signal transformers.
   4. Accessories required for a complete installation.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 01 33 00 - Submittal Procedures
   3. Section 26 05 00 - Basic Electrical Materials and Methods
   4. Section 26 06 00 - Grounding and Bonding
   5. Section 26 08 00 - Electrical Testing

1.02 SUBMITTALS

A. Product Data: Manufacturer's technical data for each product indicated.

B. Shop Drawings: Wiring and connection diagrams.

C. Output Settings Reports: Record of tap adjustments.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   2. Comply with IEEE C57.12.91.
3. Energy Efficient Transformers Rated 15 kVA and Larger: Certified as meeting NEMA TP 1, Class 1 efficiency levels when tested according to NEMA TP 2.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

PART 2 - PRODUCTS

2.01 GENERAL

A. Where products and manufacturers are listed, make submittals for proposed comparable products and substitutions in accordance with Section 01 60 00 - Product Requirements.

2.02 MATERIALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved as a comparable product:

3. GE, Electrical Distribution division.
4. Magnetek, Inc.
5. Siemens Energy & Automation, Inc.
7. Square D brand, Schneider Electric.

B. Factory assembled and tested, air cooled units for 60-Hz service.

C. Cores: Grain oriented, nonaging silicon steel.

D. Coils: Continuous windings without splices, except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.
2.03 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are internally braced to withstand seismic forces specified.

C. Cores: One leg per phase.

D. Enclosure: Ventilated, drip proof, NEMA 250, Type 2.
   1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
   2. Finish: Comply with NEMA 250 for Indoor Corrosion Protection.

E. Insulation Class: 220 DegC, UL component recognized insulation system with a maximum of 150 DegC rise above 40 DegC ambient temperature.

F. Taps for Transformers Smaller than 3 kVA: None.

G. Taps for Transformers 7.5 to 24 kVA: One (1), 5 percent tap above and one (1), 5 percent tap below normal full capacity.

H. Taps for Transformers 25 kVA and Larger: Two (2), 2.5 percent taps above and two (2), 2.5 percent taps below normal full capacity.

I. K Factor Rating: For transformers indicated to be K factor rated, comply with UL 1561 requirements for nonsinusoidal load current handling capability to degree defined by designated K-factor.
   1. Construct unit to not overheat when carrying full load current with harmonic distortion corresponding to designated K factor.
   2. Indicate value of K factor on transformer nameplate.

J. Wall Brackets: Standard brackets.

2.04 CONTROL AND SIGNAL TRANSFORMERS

A. Transformer: Self cooled, two winding dry type, rated for continuous duty, complying with NEMA ST 1, and listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If rating is not indicated, provide at least 50 percent spare capacity above connected peak load.

2.05 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.
PART 3 - EXECUTION

3.01 INSTALLATION

A. Install wall mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

B. Install floor mounting transformers level on concrete bases. Construct concrete bases not less than 4 IN larger in both directions than supported unit and 4 IN high.

3.02 CONNECTIONS

A. Ground equipment according to Section 26 06 00 - Grounding and Bonding.

B. Connect wiring according to Section 26 12 00 - Conductors and Cables – Low Voltage.

3.03 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 HRS of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage -5 percent. Submit recording and tap settings as test results.

B. Adjust buck boost transformers to provide nameplate voltage of equipment being served, ±5 percent, at secondary terminals.


PART 4 - MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 26 50 00
INTERIOR AND EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Interior building lighting fixtures.
      b. Exterior building and site lighting fixtures.
      c. Lamps.
      d. Ballasts.
      e. Light poles.
      f. Lighting control.
      g. Control Equipment Accessories.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 03 31 00 – Structural Concrete.
   3. Section 26 05 00 - Basic Electrical Materials and Methods.
   4. Section 26 12 00 - Conductors and Cables – Low Voltage.

1.02 REFERENCES

A. American National Standards Institute (ANSI).

B. Certified Ballast Manufacturers (CBM).

C. Federal Communications Commission (FCC):

D. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

E. National Electrical Manufacturers Association (NEMA):
   1. 250, Enclosures for Electrical Equipment (1000Volts Maximum).
   2. LE 4, Recessed Luminaires, Ceiling Compatibility.

F. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
   1. C82.1, Lamp Ballasts - Line Frequency Fluorescent Lamp Ballast.
   2. C82.4, Ballasts for High-Intensity Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type).
   3. C82.11, High-Frequency Fluorescent Lamp Ballasts - Supplements.

G. National Fire Protection Association (NFPA):
   1. 70, National Electrical Code (NEC).

H. Underwriters Laboratories, Inc. (UL):
   1. 248-4, Low-Voltage Fuses - Part 4: Class CC Fuses.
   2. 508, Standard for Safety Industrial Control Equipment.
   5. 1029, Standard for High-Intensity-Discharge Lamp Ballasts.
   6. 1598, Luminaires.

I. United States Department of Energy (USDOE):
   1. EPAct, the National Energy Policy Act.

1.03 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
a. Provide submittal data for all products specified in PART 2 of this Specification Section.

b. Identify fixtures by Fixture Schedule number.

c. Fixture data sheet including:
   1) Photometric performance data including candlepower distribution and coefficient of utilization (CU) table.
   2) Fixture effective projected areas for pole mounted fixtures.

d. Pole data shall include:
   1) Pole wind loading.
   2) Anchor bolt template.

e. UL nameplate data for fixtures used in Class 1 Division 1 and 2 areas.

f. See Specification Section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Lighting fixtures: See Fixture Schedule.

2. Lamps:
   a. Osram/Sylvania.
   b. General Electric.
   c. Philips.
   d. Venture.


5. Emergency transfer devices: Bodine.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

2.02 GENERAL REQUIREMENTS

A. All lighting fixtures and electrical components:
   1. UL labeled.
   2. Fixtures complete with lamps and ballasts.
   3. Rated for area classification as indicated on the Drawings.
      a. In Class I, Division 1 and 2 areas, the temperature rating of the
         luminaires and lamp combination shall not exceed the auto-
         ignition temperature of the atmosphere in which the fixture is
         used.

B. Provide all recessed fixtures with gaskets of rubber, fiberglass, or equivalent
   material to prevent light leaks around flush trim.
   1. Provide recessed fixtures with trim gaskets cemented in proper position.

C. Provide standard plaster frame for all recessed lighting fixtures installed in plaster
   walls or ceilings.
   1. Design, finish and fabricate material to preclude possibility of rust stain in
      plaster.

D. No live parts normally exposed to contact.

E. When intended for use in wet areas: Mark fixtures "Suitable for wet locations."

F. When intended for use in damp areas: Mark fixtures "Suitable for damp
   locations" or "Suitable for wet locations."

2.03 LIGHT FIXTURES

A. Fluorescent:
   1. UL 1598.
   2. NEMA LE 4 for recessed locations.
   3. Lenses: As indicated in Fixture Schedule, with the following minimums:
      a. Troffer: 100 percent virgin acrylic, conical shaped, female
         0.1875 IN, square based prisms, aligned 45 degrees to the length
         and width, 0.125 IN nominal thickness.
   4. Finish:
a. Manufacturer's standard polyester, acrylic enamel or epoxy powder coating applied after fabrication.

b. Manufacturer's standard color or special color specified in Fixture Schedule.

5. Prewired and provided with lamps that are properly mated to the ballast operating characteristics.

B. High Intensity Discharge:

1. UL 1598.

2. Finish:
   a. Manufacturer's standard polyester, acrylic enamel or epoxy powder coating applied after fabrication.
   b. Manufacturer's standard color or special color specified in Fixture Schedule.

3. Prewired and provided with lamps that are properly mated to the ballast operating characteristics.

4. Provided with safety chain.

C. Exit Signs and Emergency Lighting Units:

1. UL 924, NFPA 101.

2.04 LAMPS

A. Fluorescent:

1. T8 (265 mA) instant or rapid-start medium bipin lamps.
   a. Correlated color temperature of 3200 degrees Kelvin.
   b. Minimum color rendering index (CRI) of 70.
   c. Minimum initial lumen ratings for each lamp type shall be:
      1) 2025 lumens for 36 IN, 25 watt F25T8 lamp.
      2) 2800 lumens for 48 IN, 32 watt F32T8 lamp.

B. High Intensity Discharge (HID) Lamps:

1. Metal halide lamps:
   a. Metal halide lamps shall be pulse-start type.
1) If used in an open luminaire, the lamp shall be rated for use in an open fixture and incorporate a protective arc tube shroud design.

b. Clear lamps:

1) Correlated color temperature of 4000 degrees Kelvin.
2) Minimum color rendering index (CRI) of 65.

c. Minimum initial lumen ratings for metal halide lamps with a medium base in a vertical position shall be:

1) 14250 lumens for 150 watt, ED-17 (ANSI M102) clear lamp.


d. Minimum initial lumen ratings for metal halide lamps with a mogul base in a vertical position shall be:

1) 14250 lumens for 150 watt, ED-28 (ANSI M102) clear lamp.
2) 25000 lumens for 250 watt, ED-28 (ANSI M138) clear lamp.
3) 42000 lumens for 400 watt, ED-28 or ED-37 (ANSI M135) clear lamp.

2. Uncoated (clear) unless identified as coated in the fixture schedule.

3. The specified fixture in the fixture schedule shall dictate the required lamp operating position and base type.

4. Provide lamps that have the correct bulb shape for the fixture specified.

2.05 BALLASTS

A. Fluorescent Electromagnetic Ballasts:

1. UL 935.
2. High-efficiency energy saving electromagnetic core and coil design.
3. CBM certification for full light output.
4. Operate lamps at a frequency of 60 Hz.
5. Power factor: Greater than 90 percent.
6. Input current with Total Harmonic Distortion (THD) of less than 32 percent.
7. Lamp current crest factor: Less than 1.7, in accordance with lamp manufacturer's recommendations and NEMA/ANSI C82.1.

8. Ballast factor: Greater than the following per NEMA/ANSI C82.1:
   a. 0.925 for rapid start 265 mA (T8) and 430 mA (T12) ballasts.

9. Audible noise rating: Greater than or equal to the following:
   a. Class A for rapid start 265 mA (T8) and 430 mA (T12) ballasts.

10. Coil temperature not to exceed 150 DegF temperature rise over 40 105 DegF ambient.
    a. Maximum case temperature not to exceed 195 DegF.

11. Meet the requirements of the FCC 47 CFR 18, for non-consumer equipment for EMI and RFI.

12. Meet all applicable ANSI and IEEE standards regarding harmonic distortion and transient protection such as IEEE C62.41, Cat. A, for transient protection.

13. UL listed, Class P.

14. Fully encapsulated (potted) to ensure maximum thermal and structural integrity.

15. Contain no polychlorinated biphenyls (PCB’s).

B. Fluorescent High Frequency Electronic Ballasts:

1. UL 935.

2. "High Frequency" electronic operating lamps at a frequency of 20 KHz or higher without visible flicker.

3. Power factor: Greater than 90 percent.

4. Input current total harmonic distortion (THD) of less than 20 percent.

5. Lamp current crest factor: Less than 1.7, in accordance with lamp manufacturer's recommendations and NEMA/ANSI C82.11.

6. Instant start with lamps wired in parallel.

7. Support a sustained short to ground or open circuit of any output leads without damage to the ballast.

8. Ballast Factor: Greater than 0.85 per NEMA/ANSI C82.11.

9. Audible noise rating: Class A or better.
10. Operation in ambient temperatures up to 105 DegF without damage.
11. Light output to remain constant for a line voltage fluctuation of +5 percent.
12. Meet the requirements of the FCC 47 CFR 18, for non-consumer equipment for EMI and RFI.
13. Meet NEMA/ANSI C82.11 standards regarding harmonic distortion.
15. Comply with all applicable state and federal efficiency standards.
16. UL listed, Class P.
17. Contain no Polychlorinated Biphenyls (PCB's).

C. Fluorescent Emergency Ballasts:
1. UL 924, NFPA 101.
2. High temperature, 24 Watt-hour, maintenance-free nickel cadmium battery with charger.
3. Charging indicator light (LED) to monitor the charger and battery.
5. Light one (1) lamp for 90 minutes in 1, 2 and 3-lamp fixtures.
   a. Light two (2) lamps for 90 minutes in 4-lamp fixtures.
6. Dual input voltage (120/277V), 4 Watts input.
7. Compatible with the install lamp type.
8. Initial lumen output: 975 to 1400.
9. Contain no Polychlorinated Biphenyls (PCB's).

D. High Intensity Discharge Ballasts:
1. NEMA/ANSI C82.4, UL 1029.
2. Metal halide:
   a. Input voltage variation: +10 percent.
   b. Maximum lamp regulation spread: 20 percent.
   c. Minimum power factor: 90 percent.
d. Starting current: Not greater than operating current.

e. Maximum input voltage dip: 40 percent.

f. Crest factor: 1.5 to 1.8.

g. Types:

1) Lead-type regulators: Constant wattage autotransformer (CWA) and pulse start.

2) Lag-type regulators: Magnetic regulator and pulse start.

h. Contain no Polychlorinated Biphenyls (PCB’s).

3. Ballasts for interior use:

a. Encased and potted type.

b. Audible noise rating of B or better.

c. Built-in automatic resetting thermal protection switch.

4. Ballasts for exterior use:

a. Starting temperature: -20 DegF.

2.06 POLES

A. As scheduled or noted on the Drawings.

2.07 MAINTENANCE MATERIALS

A. Furnish a minimum of 2 or 10 percent of total of each type and wattage of lamps, whichever is greater.

B. Furnish a minimum of 10 percent of total of each type and amperage of fuses for fixtures indicated to be fused.

C. Spare parts are to be stored in a box clearly labeled as to its contents.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Coordinate fixture types with ceiling construction.

1. Provide mounting hardware for the ceiling system in which the fixture is to be installed.
B. Fasten lighting fixtures supported by suspended ceiling systems to ceiling framing system with hold down clips.

C. Provide mounting brackets and/or structural mounting support for wall-mounted fixtures.
   1. Do not support fixture from conduit system.
   2. When fixtures are supported from outlet boxes, install per NFPA 70.
   3. Supports for fixtures mounted on exterior walls shall not be attached to exterior face of the wall.

D. Provide pendant incandescent, compact fluorescent, and/or HID fixtures with swivel hangers which will allow fixture to swing in any direction but will not permit stem to rotate.
   1. Provide hangers with enclosure rating (NEMA 1, 4, or 7) equal to enclosure requirements of area in which they are installed.
   2. Swivel hangers for fixtures in mechanical equipment areas: Shock absorbing type.

E. Pendant mounted, open, industrial fluorescent fixtures:
   1. Not in continuous rows, shall be supported by conduit or by approved chains:
      a. Hardwired to ceiling mounted junction box.
   2. In continuous rows, shall be rigidly supported with conduit and fasten fixtures to each other or mount on continuous metal channel per Specification Section 26 05 00.
      a. Hardwired to ceiling mounted junction box.
      b. Provide reflector alignment clips.

F. Locate fixtures in accordance with reflected ceiling plans.

G. Locate in exact center of tile when indicated.
   1. Relocate misplaced fixtures and replace damaged ceiling materials.

H. Mount lighting fixtures at heights indicated in Specification Section 26 05 00 or per fixture schedule or as indicated on the Drawings.

I. Install exterior fixtures so that water can not enter or accumulate in the wiring compartment.
J. Where indicated provide two-level control of three (3) and/or four (4) lamp fluorescent fixtures.
   1. Provide two (2) ballasts per fixture and control inside lamp(s) in each fixture by one (1) switch or set of switches and the outside two (2) lamps by a second switch or group of switches.

K. Ground fixtures and ballasts.

3.02 POLE INSTALLATION

A. Drawings indicate the intended location of light pole.
   1. Field conditions may affect actual location.
   2. Coordinate location with all existing or new utilities and pavement.

B. Steel and Aluminum Poles:
   1. Mounted on cast-in-place foundations, as detailed on the Drawings.
      a. Concrete and reinforcing steel, in accordance with Division 3 Specification Sections.
   2. Protect pole finish during installation.
      a. Repair damage to pole finish with manufacturer approved repair kit.

C. Ground poles as indicated on the Drawings.

D. Conductors:
   1. See Specification Section 26 05 19 for required underground conductors.
   2. Use interior building wire, as specified in Specification Section 26 05 19, from pole base to fixture, #12 AWG minimum.

E. Overcurrent and Short Circuit Protection:
   1. Protect each phase with a UL Class CC fuse:
      a. Size: Three (3) times load current.
   2. Fuseholder:
      b. Accept up to a 30 A, 600 V fuse.
c. Neutral conductor shall utilize a fuseholder with a solid copper rod.
d. Conductor terminal: Adequate size for the installed conductors.

3.03 LIGHTING CONTROL

A. See 26 44 20 for lighting control equipment located in service pedestals.
B. Exterior wall mounted and pole mounted fixtures controlled as detailed on the Drawings.

3.04 ADJUST AND CLEAN

A. See Specification Section 01 74 13.
B. Replace all inoperable lamps with new lamps prior to final acceptance.
C. Aim all emergency lighting units, so that, the path of egress is illuminated.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Light Fixtures including lamps and ballast will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Light Poles will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Light Fixtures including lamps and ballast furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Light Poles furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all
work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. This section describes the minimum requirements for the SCRRRA Access Control System (ACS).

B. The system shall consist of access-control software that enables communication between IBM®-compatible personal computers and microprocessor-equipped smart controllers with distributed databases. The smart controllers make access-control decisions at doors, exits, entrances, etc., and communicate to PCs for programming instructions, event monitoring and record keeping. The controller(s) shall be designed specifically for access-control system applications.

C. The controller(s) shall receive data input from other hardware components of the system, such as readers and relays. All system controllers shall be connected to the system server(s) where event history, cardholder data and system programming data shall reside. The controller(s) shall receive data input from, and provide system data to, the controlling system server(s).

D. The system shall include, but not be limited to, all equipment, materials, labor, documentation and services necessary to furnish and install a complete and operational system to include, but not be limited to, the following functions:

1. Enabling valid access and preventing unauthorized access at facility portals.
2. Enabling alarm/alert notification of access breaches at facility portals and other points as desired.
3. Enabling data collection and management for a cardholder database at facilities.

E. The standard Access Control System used by SCRRRA is Identicard PremiSys Pro by Identicard Systems.

F. Contractor is responsible for providing and coordinating final equipment arrangements, locations, phased activities and construction methods that minimize disruption to operations and provide complete and operational systems.

G. Contractor shall coordinate interfaces to existing systems and components in order to minimize disruption to existing systems operations. Any system outages shall be coordinated with SCRRRA prior to work.

1.02 RELATED SECTIONS

A. Related Specification Sections include, but are not limited to:
1. Section 01 33 00 - Submittal Procedures
2. Section 01 78 36 - Warranties and Guarantees
3. Section 01 91 13 - General Commissioning Requirements
4. Section 26 12 00 - Conductors and Cables – Low Voltage
5. Section 26 13 00 - Raceways and Boxes
6. Section 26 14 00 - Wiring Devices
7. Section 26 41 00 - Enclosed Switches and Circuit Breakers
8. Section 28 23 00 - Video Surveillance System
9. Section 29 20 20 - Communications Services

1.03 DEFINITIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>#A</td>
<td>Ampere</td>
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<tr>
<td>ACO</td>
<td>Alarm Company Operator</td>
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<tr>
<td>ACS</td>
<td>Access Control System</td>
</tr>
<tr>
<td>CSLB</td>
<td>Contractors State License Board (California)</td>
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<tr>
<td>DIP</td>
<td>Dual In-Line Package</td>
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<tr>
<td>EOL</td>
<td>End of Line</td>
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<tr>
<td>FIPS</td>
<td>Federal Information Processing Standards</td>
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<td>HID</td>
<td>HID Corporation</td>
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<td>Hz</td>
<td>Hertz</td>
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<tr>
<td>ID</td>
<td>Identification</td>
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<tr>
<td>I/O</td>
<td>Input/Output</td>
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<tr>
<td>IP</td>
<td>Internet Protocol</td>
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<tr>
<td>IT</td>
<td>Information Technology</td>
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<tr>
<td>LAN</td>
<td>Local Area Network</td>
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<tr>
<td>LED</td>
<td>Light-Emitting Diode</td>
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<td>MB</td>
<td>Megabyte</td>
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<tr>
<td>MUX</td>
<td>Multiplexer</td>
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<tr>
<td>OSDP</td>
<td>Open Supervised Device Protocol</td>
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<tr>
<td>PC</td>
<td>Personal Computer</td>
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</table>
### 1.04 GENERAL REQUIREMENTS

**A.** All work and materials shall conform to all applicable SCRRRA, Federal, State, local and/or municipal codes and regulations governing the installation. If there is a conflict between this specification and the referenced standards, federal, state, local and/or municipal codes, it is the bidder's responsibility to immediately bring the conflict to the attention of SCRRRA for resolution. National standards shall prevail unless local codes are more stringent. Contractor shall not attempt to resolve conflicts directly with the local authorities unless specifically authorized by SCRRRA.

**B.** The controllers, reader boards and input/output boards proposed in this specification shall be compliant with UL 294. Contractor shall be responsible for filing of all applicable documents, paying all fees (including, but not limited to plan checking and permit) and securing all permits, inspections and approvals. Proof of approval shall be submitted to SCRRRA.

**C.** All controllers and connected boards, readers and the like shall be tested to ensure that a fully functioning system is designed and installed. The system supplied under this specification shall be a microprocessor-based system. The system shall utilize independently addressed, microprocessor-based controllers as described in this specification.

**D.** Contractor shall submit a detailed project plan that will describe in detail how they will approach the project, from inception to finalization. The plans must include the following information (at a minimum):

1. Equipment Schedules
2. Installation Time Lines
3. Other Trade Requirements
4. Final Acceptance Testing
5. Progress Report Sample
1.05 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00, Submittal Procedures:

1. Product Data: For each type of product indicated. Indicated in the documentation shall be the type, size, rating, style, and catalog number for all items proposed to meet the system performance detailed in this specification.

2. Shop Drawings: Provide shop drawings that are applicable and pertain to ACS provisions.
   a. Controller wiring and interconnection schematics
   b. Complete point-to-point wiring diagrams
   c. Riser diagrams
   d. Complete floor plan drawing locating all system devices and scaled plan and elevation of all equipment in the access-control system, showing the placement of each individual item of access-control equipment as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway
   e. Detailed system operational description, with any specification differences and deviations clearly noted and marked
   f. Complete system bill of material

3. Warranty: Sample of special warranty.

4. Operation and Maintenance Data: Manuals including operation and maintenance instructions, and other descriptive material as received from the manufacturers that will enable SCRRA personnel to operate, maintain, test and troubleshoot equipment.

5. Project Record Documentation: Final As-Built documentation and drawings. Details shall include (but not limited to): camera and equipment layout plans; block diagrams; wiring diagrams, paths and schedules; system (power and data) connection details; equipment mounting details; conduit, pull box, junction box and pole details; camera coverage areas; rack/cabinet/enclosure layout elevations and details.

1.06 QUALITY ASSURANCE

A. The Contractor shall be an experienced installer and integrator of access control systems and electrified door hardware who can demonstrate a minimum of three (3) years of continuous experience and technical expertise in performing work comparable in size and complexity, and whose installation and integration work was performed skillfully in a satisfactory manner and on time.
B. The Contractor shall be qualified (as appropriate) by the manufacturers of the proposed equipment to install, service and maintain each manufacturer’s equipment.

C. The Contractor must be an authorized Identical Partner.

D. The Contractor shall have an office and service department located within the Metrolink service area.

E. Required Contractor licenses:

1. Issued by the State of California CSLB:
   a. C-7 - Low Voltage Systems Contractor
   b. C10 - Electrical Contractor
   c. C16 - Fire Protection Contractor

2. Alarm Company Operator (ACO) License

F. The Contractor shall serve as the single point of responsibility for the work described in this section.

G. Products shall be manufactured by firms regularly engaged in manufacturing products described in this Section.

H. All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Refer to the manufacturer's riser/connection diagram and details for all specific system installation/termination/wiring data.

I. Contractor shall provide personnel certified by the equipment manufacturer to:

1. Assist in the installation of the equipment
2. Check the installation before the equipment is placed into operation
3. Assist in the performance of field tests
4. Assist in the hardware configuration and system integration
5. Train the Authority operations and maintenance staff in the care, operation, troubleshooting and maintenance of the equipment.

J. Proof of qualifications shall be readily available.

1.07 SUBSTITUTION OF EQUIPMENT

A. Approval of alternate or substitute equipment or material in no way voids specification requirements.
B. Under no circumstances shall SCRRA be required to prove that an item proposed for substitution is not equal to the specified item. It shall be mandatory that the Contractor submits to SCRRA all evidence to support the contention that the item proposed for substitution is equal to the specified item. SCRRA’s decision as to the equality of substitution shall be final and without further recourse.

C. In the event that SCRRA is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if SCRRA is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the expenses in connection with such additional services shall be paid by the Contractor and may be deducted from any moneys owed to the Contractor.

D. If the deviation is not approved by SCRRA, it remains the Contractor’s responsibility to provide what is required in the Contract Documents.

1.08 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall be responsible for all receiving, handling and storage of all equipment and materials for the project.

B. Coordinate with SCRRA if storage space is required on the project site.

1.09 FIELD/SITE CONDITIONS

A. The Contractor shall be responsible for inspecting the job site and becoming familiar with the conditions under which the work will be performed. Inspection of the facility may be made by appointment with SCRRA. Contractors are requested to inspect the building prior to submitting any technical data for approval or commencement of work.

B. The Contractor shall be responsible for prior coordination of all work and demolition with SCRRA.

C. The Contractor shall verify that the proposed equipment and methods of installation are compatible with the existing conditions.

D. Notify SCRRA in writing if modifications of the existing facility are required in order to accommodate the new equipment. These modifications shall be reviewed and approved by SCRRA.

E. The Contractor shall protect all facility property (buildings, walls, floors, etc.) from damage resulting from installation work. Any and all damage to facility property caused by installation work shall be repaired by the Contractor at its own expense.

F. The Contractor shall clean up areas in which it has been working following each day’s work. Dispose of all trash and waste in the appropriate designated areas.
G. Upon project completion, return project site to a condition equal to or better than original.

1.10 WARRANTY

A. The Contractor shall warranty all materials, installation and workmanship for one (1) year from final acceptance.

1. The Contractor shall be responsible for and make good, without any expense to SCRRA, any and all defects arising during this warranty period that are due to imperfect materials, equipment, improper installation or poor workmanship.

B. Submit a copy of all manufacturer warranty information.

PART 2 - PRODUCTS

2.01 GENERAL

A. Unless otherwise specified, products for the ACS shall be consistent with and compatible with the established standards for SCRRA ACS.

B. The specified hardware to be used with the ACS management software shall be hardware designed for use with Identicard PremiSys Pro software by Identicard Systems.

C. Any existing legacy hardware (e.g. Identicard Series 9000 Panels) shall be replaced with hardware listed in this section, and designed for use with the Identicard PremiSys Access Control System.

D. Latest technology available: Products shall be provided as specified. In the event the manufacturers of specified products and materials have upgraded or replaced the specified products and materials with newer or improved technologies at the time of purchase, the newer or improved products or materials shall be provided unless they are incompatible with the rest of the SCRRA ACS or so directed by SCRRA (submit Request For Information if in doubt). Latest technology products and materials shall be operationally and functionally equivalent or superior to the specified products and materials. Products and materials shall be purchased by the Contractor in a timely manner to meet construction schedules, but shall not be purchased so far advanced of the date(s) of installation that they become technologically obsolete or replaced with newer technologies.

E. Provide and install required cabling, connectors, patch cords, resistor packs, terminators, and all other miscellaneous items required for a fully functional system.

F. Access control panels and all supporting system power supplies shall typically be located in temperature controlled telecommunications rooms (e.g. server room, data center, etc.), unless otherwise specified.
G. In addition to any acceptance testing requirements specified elsewhere, the ACS shall be fully tested and accepted. All ACS equipment shall be tested. Test results shall be recorded and submitted in a formal report to SCRRA for review and acceptance.

2.02 ACCESS CONTROL MANAGEMENT SOFTWARE

A. The standard ACS management software used by SCRRA is Identicard PremiSys Pro by Identicard Systems. No exceptions.

B. Contractor to provide Identicard PremiSys Pro software upgrade or new installation to replace any non-PremiSys Pro management software, as required by SCRRA.

C. SCRRA utilizes the ID badging (PremiSys Pro) and mobile app features of the PremiSys Pro software.

D. Provide additional software client licenses as required by SCRRA. This shall include, but not limited to:

1. PremiSys Pro Client License
   a. License type dependent on number of concurrent client connections

2. PremiSys Pro ExpressionsID Client License
   a. License type dependent on number of concurrent client connections

3. PremiSys ID Mobile License

2.03 ACCESS CONTROL EQUIPMENT

A. Two-Reader Controller

1. The Two-Reader Controller shall be of a distributed database design and provide access control, alarm monitoring and time zone control for both access to and egress from selected areas. The Two-Reader Controller shall process all data transmitted to and from the I/O boards connected to it. The controller shall use 12 VDC for power and be intended for use in low voltage, Class 2 circuits only.

2. Incorporated on the Two-Reader Controller shall be memory as follows:
   a. 1 MB SRAM for transactions and new card information
   b. 16 MB non-volatile flash memory for card and system information
   c. 16 MB SDRAM for system firmware and database storage for the application
   d. A 3-volt lithium coin cell shall provide SRAM and clock backup.
3. Two-way communications between the controller and the host computer/server shall be via a primary Ethernet 10/100Base-T interface or optional serial RS-232 port. The Ethernet port and serial port for RS-232 connections shall be built into the controller. When Ethernet is the connection means, the number of controllers possible in a system shall be limited only by the network capacity and bandwidth. When using RS-232 connections the system shall allow one controller per computer port. Communication between the controller and host shall be selectable from among the baud rates 2400, 9600, 19,200, 38,400 and 115,200.

4. The Two-Reader Controller shall provide two reader ports built into the controller. Such reader ports shall support up to two (2) reading devices of the same or different technologies.

5. The Two-Reader Controller shall be connectable to a variety of system I/O boards that act as interfaces between the controller and auxiliary access-control and door hardware such as locks, input devices and switches. These I/O boards shall include reader boards, input boards and output boards, as well as multiplexer boards. All communications lines to I/O boards shall be supervised in the system, and transactions shall be provided in the system to alert the operator of offline or disconnect statuses. Communications between any controller and its I/O boards shall be via serial RS-485 and/or TCP/IP over Ethernet. It shall be possible to connect up to 32 I/O boards to a single Two-Reader Controller. It shall also be possible for each Two-Reader Controller to receive input from a maximum of 64 readers, including readers connected to the two reader ports built into the controller. Communication between the controller and I/O boards shall be selectable from among the baud rates 2400, 9600, 19,200 and 38,400.

6. The Two-Reader Controller shall be capable of providing redundant communications to the host computer/server for use in the event that the primary Ethernet connection to the host is lost. The serial RS-232 interface serves as the means for redundant communication.

7. Any controller within the network of controllers shall have an address that is different from any other on the same port of the PC. The Two-Reader Controller’s address shall be selected by means of a configuration Web page stored on the Two-Reader Controller and accessed through a Web browser using a default IP address.

8. The Two-Reader Controller shall provide eight (8) supervised inputs for use as door-position inputs, request-to-exit inputs etc. The states of the inputs shall be as follows: normally open; normally closed; 1 K normal, 2 K active; and 2 K normal, 1 K active. It additionally shall be possible to set the debounce and hold times for each input on the board. It shall be possible to set all input configuration via the system software.
9. Held-open times (the time during which a door may be held open without generating a system alarm) for inputs on the board assigned as door-position points shall be software-selectable in two-second increments between 2 and 65,534 seconds.

10. All input points shall have a corresponding LED on the board that indicates the state of the point.

11. The Two-Reader Controller shall include two (2) Form-C, noninductive relay outputs for door-lock control or alarm signaling. Control of the relays shall be software-assignable to be triggered by card presentations, time zones and/or other system actions. The contact ratings shall be 5A at 30 VDC. The relays shall be configurable for normal (relay energized when “on”) or inverted (relay de-energized when “on”) action. Pulse time of a relay used as a door-lock relay shall be software-selectable between 1 and 255 seconds.

12. It shall be possible via the system software to link an input or relay on the Two-Reader Controller to cause an action on any other relay in the system and to select the action that a linked relay will take when the triggering input or relay is activated.

13. The Two-Reader Controller shall have a dedicated input point for optional connection to a controller enclosure tamper switch and another dedicated input point for optional connection to a power-loss monitoring device. Systems requiring use of one of the available system input points for this monitoring shall be unacceptable.

14. The system shall allow the incorporation of a rechargeable battery as part of the power supply to provide full functionality for the controller, system communications and board-powered readers in the event of a power failure.

15. Two-Reader Controllers shall be housed in heavy-gauge steel enclosures with hinged front doors. Conduit knockouts shall be available on sides and backs of the enclosures. Each enclosure shall be lockable with its own set of keys.

16. Identicard PremiSys Two-Reader Controller, model PREM-CTRL2RDR, or approved equal.

B. Two-Reader Board

1. The Two-Reader board shall be connected to a system controller and act as an interface between this controller and any of a variety of readers that can read ABA-formatted data or Wiegand®-formatted data from smart cards, proximity cards, magnetic-stripe cards, bar-coded cards or cards possessing a combination of these technologies. The board shall also be capable of supporting tri-stated LED control and buzzer control.
2. The Two-Reader board shall support up to two (2) reading devices of the same or different technologies, the type being selectable through the application software. Systems that are unable to use readers of different technologies on the same board or require a change in software, firmware or "other" interface devices shall be unacceptable.

3. The Two-Reader board shall use quick-disconnect terminal blocks for all interconnections to the interface. The Two-Reader board shall be intended for use in low voltage, Class 2 circuits only.

4. The Two-Reader board shall communicate to a controller via a two-wire RS-485 interface, which shall allow multi-drop communication on a single bus of up to 4,000 feet (1,200 m). It shall be possible to connect up to 64 I/O boards, of which any number can be Two-Reader boards, to a single IP Controller described in this specification, or up to 32 I/O boards, of which any number can be Two-Reader boards, to a single Two-Reader Controller described in this specification. All communications lines shall be supervised in the system, and transactions shall be provided in the system to alert the operator of offline or disconnect statuses. Provision to set end-of-line (EOL) resistance for the board itself shall be built into the board should this resistance be needed.

5. Each Two-Reader board shall be uniquely addressable by the user through the settings of a dual in-line package (DIP) switch on the board. In addition, this DIP switch shall be used to select the baud rate of communication with the controller.

6. All two-reader boards shall be housed in heavy-gauge steel enclosures with hinged front doors. Conduit knockouts shall be available on sides and backs of the enclosures. Each enclosure shall be lockable with its own set of keys.

7. The Two-Reader board shall provide sensor monitoring via eight (8) supervised inputs, which can be used as door-position inputs, request-to-exit inputs and for other purposes. The states of the inputs shall be as follows: normally open; normally closed; 1 K normal, 2 K active; and 2 K normal, 1 K active. It additionally shall be possible to set the debounce and hold times for each input on the board. It shall be possible to set all input configuration via the system software.

8. Held-open times (the time during which a door may be held open without generating a system alarm) for inputs on the board assigned as door-position points shall be software-selectable in two-second increments between 2 and 65,534 seconds.

9. Each input point shall have a corresponding LED on the board that indicates the state of the point.
10. It shall be possible via the system software to link any input or relay on the Two-Reader board to cause an action on any other relay in the system and to select the action that the linked relay will take when the triggering input or relay is activated.

11. When using the two readers on the same door, for example, to provide antipassback capability, it shall be possible to assign a single input point on the board as the door-position point shunted by either reader connected to the board. It shall also be possible to assign a single relay on the board as the door-lock relay controlled by either reader.

12. The Two-Reader board shall also include six (6) Form-C, non-inductive contact relays with ratings of 5A at 28 VDC for optional use in controlling door locks, alarm signals or other devices. Control of the relays shall be software-assignable to be triggered by a reading device, cardholder, time zone and/or other system actions. The relays shall be configurable for normal (relay energized when “on”) or inverted (relay de-energized when “on”) action. Pulse time of a relay used as a door-lock relay shall be software-selectable between 1 and 255 seconds.

13. It shall also be possible to define the response desired for each relay when communications go offline between the Two-Reader board and the controller: The relay shall be active, the relay shall be inactive, or the relay shall maintain its status at the moment communications are lost. Each relay shall have a corresponding LED on the board that indicates when the relay is energized.

14. The Two-Reader board shall also provide two digital inputs for optional use to indicate tamper and power fault status.

15. It shall be possible via the system software to link any relay on the Two-Reader board to cause an action on any other relay on the same board or on any other board wired to the same controller and to select the action that the linked relay will take when the triggering relay is activated.

16. The Two-Reader board shall accept 12 VDC for power. It shall be possible to select the input voltage to be passed through the board to the reader, with a maximum of 125mA available per reader port. The power selection shall be made via a jumper on the board and shall apply to both reader ports.

17. The Two-Reader board shall have a dedicated input point for optional connection to an enclosure tamper switch and another dedicated input point for optional connection to a power-loss monitoring device. Systems requiring use of one of the available input points on the Two-Reader board for this monitoring shall be unacceptable.

18. Identical PremiSys Two-Reader Board, model PREM-BRD2RDR, or approved equal.
C. Input Board

1. The Input Board shall be connected to a system controller and provide sensor monitoring and output control via 16 supervised inputs. The states of the inputs shall be as follows: normally open; normally closed; 1 K normal, 2 K active; and 2 K normal, 1 K active. It additionally shall be possible to set the debounce and hold times for each input on the board. Each input point shall have a corresponding LED on the board that indicates the state of the point.

2. The Input Board shall also include two (2) Form-C contact relays for optional use in controlling door strikes or other devices. Control of the relays shall be software-assignable to be triggered by system actions. Pulse time of the relays shall be software-selectable between 1 and 255 seconds, inclusive.

3. It shall be possible via the system software to link any input or relay on the Input Board to cause an action on any other relay in the system and to select the action that a linked relay will take when the triggering input or relay is activated.

4. All interconnections to the interface shall be via quick-disconnect terminal blocks. The Input Board shall be intended for use in low voltage, Class 2 circuits only.

5. The Input Board shall communicate to a controller via a two-wire RS-485 interface, which shall allow multi-drop communication on a single bus of up to 4,000 feet (1,200 m). It shall be possible to connect up to 64 I/O boards, all or some of which can be input boards, to a single IP controller described in the specification, or up to 32 I/O boards, all or some of which can be input boards, to a single Two-Reader controller described in the specification. All communications lines shall be supervised in the system, and transactions shall be provided in the system to alert the operator of offline or disconnect statuses. Provision to set end-of-line (EOL) resistance for the inputs 1 through 16 and for the board itself shall be built into the board should this resistance be needed.

6. Each input board shall be uniquely addressable by the user through the settings of a dual in-line package (DIP) switch on the board. In addition, this DIP switch shall be used to select the baud rate of communication with the controller.

7. All input boards shall be housed in heavy-gauge steel enclosures with hinged front doors. Conduit knockouts shall be available on sides and backs of the enclosures. Each enclosure shall be lockable with its own set of keys.

8. The Input Board shall accept 12 VDC for power.
9. The Input Board shall have a dedicated input point for optional connection to an enclosure tamper switch and another dedicated input point for optional connection to a power-loss monitoring device. Systems requiring use of one of the available input points on the Input Board for this monitoring shall be unacceptable.

10. Identicard PremiSys Input Board, model PREM-BRDIN, or approved equal.

D. Output Board

1. The Output Board shall be connected to a system controller and provide output control via 16 Form-C, noninductive relays with ratings of 5A at 28 VDC. The relays shall be configurable for normal (relay energized when “on”) or inverted (relay de-energized when “on”) action. It shall also be possible to define the response desired for each relay when communications go offline between the Output Board and the controller: The relay shall be active, the relay shall be inactive, or the relay shall maintain its status at the moment communications go offline. Each relay shall have a corresponding LED on the board that indicates when the relay is energized.

2. Control of the relays shall be software-assignable to be triggered by a reading device, cardholder, time zone and/or other system actions. The relays shall be configurable for normal (relay energized when “on”) or inverted (relay de-energized when “on”) action. Pulse time of the relays shall be software-selectable between 1 and 255 seconds, inclusive.

3. It shall be possible via the system software to link any relay on the Output Board to cause an action on any other relay in the system and to select the action that a linked relay will take when the triggering input or relay is activated.

4. All interconnections to the Output Board shall be via quick-disconnect terminal blocks. The Output Board shall be intended for use in low voltage, Class 2 circuits only.

5. The Output Board shall communicate to a controller via a two-wire RS-485 interface, which shall allow multi-drop communication on a single bus of up to 4,000 feet (1,200 m). It shall be possible to connect up to 64 I/O boards, all or some of which can be output boards, to a single IP Controller described in the specification, or up to 32 I/O boards, all or some of which can be output boards, to a single Two-Reader Controller described in the specification. All communications shall be supervised in the system, and transactions shall be provided in the system to alert the operator of offline or disconnect statuses.

6. Each Output Board shall be uniquely addressable by the user through the settings of a dual in-line package (DIP) switch on the board. In addition, this DIP switch shall be used to select the baud rate of communication with the controller.
7. All output boards shall be housed in heavy-gauge steel enclosures with hinged front doors. Conduit knockouts shall be available on sides and backs of the enclosures. Each enclosure shall be lockable with its own set of keys.

8. The Output Board shall accept 12 VDC for power.

9. The Output Board shall have a dedicated input point for optional connection to an enclosure tamper switch and another dedicated input point for optional connection to a power-loss monitoring device. Systems requiring use of one of the available input points on the Output Board for this monitoring shall be unacceptable.

10. Provision to set end-of-line (EOL) resistance for the board itself shall be built into the board should this resistance be needed.

11. Identicard PremiSys Output Board, model PREM-BRDOUT, or approved equal.

E. Eight-Channel Multiplexer (MUX) Board

1. The eight-channel MUX board shall allow a single communication port to be expanded to eight two-wire RS-485 channels, thus facilitating star wiring topology when needed. The two-wire RS-485 interface shall allow multi-drop communication on a single bus of up to 4,000 feet (1,200 m). The channels on the multiplexer shall be universal with regard to connected devices. The eight-channel MUX board shall be intended for use in low voltage, Class 2 circuits only.

2. The communications interface for the primary port on the board shall be jumper-selectable as RS-232 or RS-485. It shall be possible to connect the eight-channel MUX board between an IP or Two-Reader controller and “downstream” I/O boards.

3. The eight-channel MUX board shall use quick-disconnect terminal blocks for all interconnections.

4. The eight-channel MUX board shall be “invisible” to the system as an I/O board, and so its use shall not affect the number of I/O boards connectable to a controller.

5. Turn around delay (the time a device must wait before it can begin a new transmission) shall be user-configurable by DIP switches.

6. All eight-channel MUX boards shall be housed in heavy-gauge steel enclosures with hinged front doors. Conduit knockouts shall be available on sides and backs of the enclosures. Each enclosure shall be lockable with its own set of keys.

7. The eight-channel MUX board shall accept 12 VDC ± 15% at 250 mA for power.
8. Identicard PremiSys Eight-Channel MUX Board, model PREM-BRD8MUX, or approved equal.

F. Power Supply

1. 12 VDC Power
   a. Provide and install as required for 12 VDC components in the ACS (not powered by other sources).
   b. Power supply shall be rated for use in low voltage, Class 2 circuits.
   c. Input:
      1) 115 VAC, 60 Hz, 3.5 amp
      2) Fuse rated @ 3.5 amp / 250 V
   d. Output:
      1) 12 VDC or 24 VDC selectable output
      2) 2.5 amp total supply current
      3) Filtered and electronically regulated output
      4) Short circuit and thermal overload protection
   e. Battery backup:
      1) Built-in charger for sealed batteries
      2) Automatic switch over to stand-by battery in the event of power failure
      3) Zero voltage drop when switched over to battery backup
   f. Maintenance free batteries shall be provided with all power supplies. Batteries shall be sized to allow at least four (4) hours of power backup.
   g. Power supply shall be housed in a dedicated heavy-gauge steel enclosure with a hinged front door and conduit knockouts available on the sides of the enclosure. Each enclosure shall be lockable with its own set of keys.
   h. Power supply shall be located next to the access control panels.
   i. Altronix AL300ULX with compatible batteries (for battery backup), or approved equal.
2. 24 VDC Power
   
a. Provide and install as required for 24 VDC components in the ACS (not powered by other sources).
   
b. Power supply shall be rated for use in low voltage, Class 2 circuits.
   
c. Input:
      1) 115 VAC, 60 Hz, 4.2 amp
      2) Fuse rated @ 3.5 amp / 250 V
   
d. Output:
      1) 24 VDC output
      2) Up to 10 amp of continuous supply current
      3) Minimum of 16 Class 2 Rated PTC protected power-limited outputs
      4) Filtered and electronically regulated output
      5) Short circuit and thermal overload protection
   
e. Battery backup:
      1) Built-in charger for sealed batteries
      2) Automatic switch over to stand-by battery in the event of power failure
      3) Zero voltage drop when switched over to battery backup
   
f. Maintenance free batteries shall be provided with all power supplies. Batteries shall be sized to allow at least four (4) hours of power backup.
   
g. Power supply shall be housed in a dedicated heavy-gauge steel enclosure with a hinged front door and conduit knockouts available on the sides of the enclosure. Each enclosure shall be lockable with its own set of keys.
   
h. Power supply shall be located next to the access control panels.
   
i. Altronix AL1024ULXPD16CB with compatible batteries (for battery backup), or approved equal.
G. Surge Protection

1. All ACS components installed outdoors or exposed to lightning shall be provided with surge and lightning protection. Provide and install UL listed multi-stage protection on all low voltage and signal transmission lines.

2. 120 VAC surge suppression devices:

   a. Edco HSP121BT-1RU, or approved equal.

3. Low voltage connections:

   a. Edco FAS-1 series surge suppressor, or approved equal.

4. RS-485 or RS-422 connections:

   a. Edco PC642C-008LC & PCB1B-WKEY, or approved equal.

H. Electrified Door Hardware

1. Electrified door hardware shall consist of components typically required for access control. This includes (but not limited to):

   a. Card reader
   b. Electrified lock
   c. Door position switch
   d. Request to exit device

2. Contractor shall coordinate, furnish and install all required electrified door hardware and associated power supplies. Contractor shall complete all required connections and terminations for intended operation, and shall interface this equipment with the ACS.

3. Electrified door hardware shall be compatible with associated door configuration. SCRRA shall review and approve all proposed electrified door hardware configurations prior to installation.

4. Contractor shall be responsible for preparing or retrofitting any door for access control, if required.

I. Card Reader

1. Card readers shall be compatible with SCRRA issued proximity access cards.

2. The readers shall operate at 13.56 MHz at 13.56 MHz and 125 KHz in the same reader device, and shall operate across a voltage range of 5 VDC to 16 VDC. The readers shall be manufactured with at least 10.5% of recycled content.
3. The readers shall support multiple technologies (iCLASS® Seos™ and iCLASS SE® credential platforms, standard iCLASS, MIFARE®, and MIFARE DESFire® EV1) and shall utilize Open Supervised Device Protocol (OSDP) for secure, bidirectional communication. The readers shall provide simultaneous support for 125kHz HID Prox®, Indala®, AWID and EM4102, and shall be FIPS 201 compliant.

4. The readers shall provide an operating reading distance from .5 inches (1.3 centimeters) to 3.5 inches (8.6 centimeters) depending on reader model and credential used.

5. Card reader shall be the appropriate model for the associated door application and configuration, or as required by SCRRA.


7. Card Reader with Keypad: HID multiCLASS SE model RPK40 (no substitutions)

J. Cable and Wire

1. Low voltage cable and wire shall be furnished and installed as required

2. Cable and wire shall be selected, sized and used as appropriate for the device application in accordance with the device manufacturer's specifications, power requirements, and length of cable/wire run

3. Manufacturers: Subject to compliance with requirements, provide products of one of the following, or equal approved as a comparable product:
   a. Belden
   b. West Penn Wire
   c. Alpha Wire Company
   d. General Cable

K. Proximity Access Card

1. The standard proximity access card used by SCRRA is HID model 1386-LGGMN ISOProx II. No exceptions.

L. Card Printer

1. The standard proximity access card printer used by SCRRA is HID model Fargo DTC4500e, single-sided card printer with Ethernet. No exceptions.

2. Printer Cartridge
Section 28 13 00
ACCESS CONTROL SYSTEM (ACS)

a. Compatible with Fargo DTC4500e card printer
b. YMCKO color ribbon
c. Includes cleaning roller and overlay panel
d. Produces a minimum of 250 images
e. HID Fargo 45200, or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide, install and make fully operational all components required for a fully functional system.

B. Install all system components, including furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and as shown, and shall furnish all necessary interconnections, services, and adjustments required for a complete and operable system as specified and shown. Control signal, communications, and data transmission line grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

C. System installation and construction methods shall be installed in accordance with this specification, applicable SCERRA engineering standards, manufacturer's instructions, requirements of the State of California and all applicable building and fire codes.

D. Contractor shall install equipment to meet Seismic Zone 4 requirements of the State of California and as stated herein. Where undefined by codes and standards, Contractor shall apply a safety factor of at least two (2) times the rated load to all fastenings and supports of system components.

E. Coordinate work with SCERRA, existing conditions and applicable trades to verify exact routing of cable, wires, conduits, raceways, etc. prior to installation. Verify final location and mounting height of all equipment with SCERRA prior to installation.

F. Contractor shall use existing conduit and surface raceway where possible and practicable. All work shall be concealed using existing facility infrastructure throughout project site. If concealment is impossible or impractical, SCERRA shall be notified before starting that part of the work.

G. Where required, Contractor shall be responsible for cutting, patching, coring and associated work for the system at no additional cost to SCERRA.

H. All conduit and sleeve openings used for the installation of the ACS shall be waterproofed or fireproofed in compliance with State and Local Building and Fire Codes.
I. All building conduits and sleeves installed or used for the installation of ACS shall be fire stopped, or re-fire stopped, upon cable placement through such pathways.

J. Contractor shall patch all openings remaining around and inside all conduit, sleeves and cable penetrations devices to maintain integrity of any fire rated wall, floor, ceiling, etc.

K. All cables and patch cables shall have a label attached at both ends. All equipment components shall have a label specifying pertinent information and shall be clearly visible on the exterior of equipment. Contractor shall confirm specific labeling requirements with SCRRA prior to cable installation or termination, and equipment installation.

L. Calibrate all equipment.

M. Inspect each component, determine obvious defects, and correct.

N. All electrical work shall be done in accordance with Division 26 of the SCRRA Standard Specifications.

O. Coordinate with SCRRA IT department for interface with LAN system.

P. Coordinate with SCRRA to interface with all electric locks.

Q. All communications cables shall be kept away from power circuits.

3.02 PROGRAMMING AND SYSTEM CONFIGURATION

A. Contractor shall assist SCRRA with implementing all new ACS equipment into the current SCRRA access control management system deployed agency-wide.

B. Contractor shall provide qualified personnel in the Identicard PremiSys Access Control System to program, configure and integrate new ACS equipment into SCRRA’s existing access control system.

C. Coordinate with applicable SCRRA departments and personnel, when required.

3.03 TESTING

A. Perform tests as recommended by the manufacturer or as required to ensure that all ACS equipment is operating properly and meets specified requirements. Correct all deficiencies detected and retest affected components.

B. Types of applicable tests shall include, but not limited to:

1. Card reader controlled doors
   a. Valid card read
   b. Invalid card read
   c. Valid request-to-exit
d. Door forced open  
e. Door held open  
f. Door shunt  
g. Local alarm

2. Alarm and monitor points

3. ACS input and out interfaces

C. Upon successful completion of tests, Contractor shall submit test results in a formal report. The report shall include the following information (at a minimum):
   1. Complete listing of all new ACS equipment installed  
   2. Name(s) of personnel conducting test  
   3. Date & time of test  
   4. Test description  
   5. Results of test  
   6. Any deficiencies found, corrective measures and results of retest

D. Certify that all new ACS equipment has been tested and is ready for commissioning.

3.04 COMMISSIONING

A. Commissioning is the process by which the Contractor will demonstrate to SCRRA that it has completed the project in conformance with the contract documents and that the project will perform as specified in the contract documents.

B. The Contractor shall be Manufacturer certified and solely responsible for providing all test and commissioning equipment, tools, software, programming, programming support and incidentals and qualified technicians to start–up, calibrate, debug and verify proper function of the systems and subsystems.

C. The responsibilities of the Contractor during commissioning shall be to assign representatives with expertise and authority to act on its behalf, and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
   1. Evaluate performance deficiencies identified in test reports and, in collaboration with the entity responsible for system and equipment installation, recommend and perform corrective action.
   2. Resolve issues recorded in the test reports.
3. Organize and lead the commissioning team and coordinate commissioning process activities with the construction schedule.

4. Review and accept checklists provided by the construction manager or SCRRRA. Complete checklists as work is completed, and provide them to the construction manager or SCRRRA.

5. Complete commissioning process test procedures including specific construction checklists and commissioning process test procedures.

6. Conduct an operational demonstration in which the new equipment shall function in normal operation mode, and shall operate completely error-free in terms of hardware, software and overall system performance. Any equipment failure during the demonstration will terminate the demonstration. Correct failure and restart demonstration. Demonstration shall run for a specified period of time as designated by SCRRRA. Commissioning will be considered complete demonstration is completely error-free.

7. Contractor shall witness systems, assemblies, equipment, and component start-up. Compile test data, inspection reports, and certificates; include them in the printed systems manual and commissioning process report.

3.05 CLOSEOUT ACTIVITIES AND ACCEPTANCE

A. Completion of successful installation, final tests and commissioning, receipt of test reports and as-built documentation, and successful performance of the installed equipment and system for a thirty (30) day period will constitute Final Acceptance.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Access Control System (ACS) will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Access Control System (ACS) furnished and completed in accordance with the Contract Documents will be paid for as at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall be full compensation for furnishing all labor, materials, tools, equipment, supplies, supervision and incidentals necessary for the ACS, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 28 23 00
VIDEO SURVEILLANCE SYSTEM (VSS)

PART 1 - GENERAL

1.01 SUMMARY

A. This section describes the general requirements for Video Surveillance System (VSS) equipment. The VSS to be installed at stations and various SCRRA facilities shall consist of the following major equipment:

1. Network (IP) camera
2. Local Area Network (LAN) Ethernet switch distribution
3. Network Video Recorder (NVR) with Video Management Software (VMS)
4. Uninterruptable Power Supply (UPS)
5. Power supplies
6. Cables, wires and connectors
7. Miscellaneous equipment such as mounting poles, brackets, enclosures, racks, conduits, pull boxes, etc.

B. Contractor is responsible for providing and coordinating final equipment arrangements, locations, phased activities and construction methods that minimize disruption to operations and provide complete and operational systems.

C. All network video products proposed shall conform to ONVIF (Open Network Video Interface Forum) Profile S.

D. The standard VSS cameras to be installed throughout stations and various SCRRA facilities will communicate with the localized NVR via Internet Protocol (IP) over a dedicated VSS LAN.

E. The installation of VSS cameras and related equipment shall include the use of Pan-Tilt-Zoom (PTZ), 180-degree and 360-degree color cameras only. Fixed cameras require SCRRA approval for use prior to installation.

1.02 RELATED SECTIONS

Related Specification Sections include, but are not limited to:

A. Section 01 33 00 - Submittal Procedures

B. Section 01 78 36 - Warranties and Guarantees
C. Section 01 91 13 - General Commissioning Requirements
D. Section 26 12 00 - Conductors and Cables – Low Voltage
E. Section 26 13 00 - Raceways and Boxes
F. Section 26 14 00 - Wiring Devices
G. Section 26 41 00 - Enclosed Switches and Circuit Breakers
H. Section 29 20 20 - Communications Services
I. Section 34 44 12 - Customer Information System (CIS)

1.03 DEFINITIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>CAT-6</td>
<td>Category 6</td>
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<tr>
<td>CIS</td>
<td>Customer Information System</td>
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<td>EIA</td>
<td>Energy Information Administration</td>
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<td>EIS</td>
<td>Electronic Image Stabilization</td>
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<td>FOPP</td>
<td>Fiber Optic Patch Panel</td>
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<td>FOV</td>
<td>Field of View</td>
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<td>GB</td>
<td>Gigabyte</td>
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<tr>
<td>Gbps</td>
<td>Gigabits per Second</td>
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<td>GHz</td>
<td>Gigahertz</td>
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<td>HD</td>
<td>High Definition</td>
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<td>HDD</td>
<td>Hard Disk Drive</td>
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<td>HDTV</td>
<td>High Definition Television</td>
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<td>Hz</td>
<td>Hertz</td>
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<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
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<tr>
<td>IP</td>
<td>Internet Protocol</td>
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<td>JPEG</td>
<td>Joint Photographic Experts Group</td>
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<td>KVM</td>
<td>Keyboard-Video-Mouse</td>
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<td>LAN</td>
<td>Local Area Network</td>
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<td>LCD</td>
<td>Liquid Crystal Display</td>
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<tr>
<td>Mbps</td>
<td>Megabits per Second</td>
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<td>MIMO</td>
<td>Multiple-Input and Multiple-Output</td>
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<td>MMFO</td>
<td>Multimode Fiber Optic</td>
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<td>MP</td>
<td>Megapixel</td>
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Submit the following in accordance with Section 01 33 00, Submittal Procedures:

A. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings and finishes.
B. Shop Drawings: For video surveillance. Include plans, elevations, sections, details and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.

3. Dimensioned plan and elevations of equipment racks, control panels and consoles.

4. UPS: Sizing calculations.

5. Wiring Diagrams: For power, signal and control wiring.

C. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test and description of tests performed on bench prior to installation.

D. Warranty: Sample of special warranty.

E. Operation and Maintenance Data: Manuals including operation and maintenance instructions, and other descriptive material as received from the manufacturers that will enable SCRRA personnel to operate, maintain, test and troubleshoot equipment.

F. Project Record Documentation: Final As-Built documentation and drawings. Details shall include (but not limited to): camera and equipment layout plans; block diagrams; wiring diagrams, paths and schedules; system (power and data) connection details; equipment mounting details; conduit, pull box, junction box and pole details; camera coverage areas; rack/cabinet/enclosure layout elevations and details.

1.05 QUALITY ASSURANCE

A. Contractor shall be an experienced Systems Integrator and Installer who can demonstrate a minimum of four (4) years of continuous experience and technical expertise in performing work comparable in size and complexity, and whose installation and integration work was performed skillfully in a satisfactory manner and on time.
1. The Contractor shall furnish all specified components, shall be of established reputation and experience in the field of Video Surveillance Systems, shall be an Axis Communications, Inc. Silver level Channel Partner, and qualified (as appropriate) by the manufacturers of the proposed equipment to install, service and maintain each manufacturer’s equipment. Contractor shall offer proof of qualifications or certifications by submitting a copy of qualifications or certifications with the Bid.

2. The Contractor shall provide professionally trained fiber technicians to handle fiber optic cable installation. Technicians shall install and supervise installation during the project. All installation personnel shall be licensed as required by local and/or state jurisdictions.

3. The Contractor shall serve as the single point of responsibility for the work described in this section.

B. Products shall be manufactured by firms regularly engaged in manufacturing products described in this Section.

C. Contractor shall provide personnel certified by the equipment manufacturer to: assist in the installation of the equipment; check the installation before the equipment is placed into operation; assist in the performance of field tests; assist in the hardware configuration; and train the Authority operations and maintenance staff in the care, operation, troubleshooting and maintenance of the equipment.

1.06 SUBSTITUTION OF EQUIPMENT

A. Approval of alternate or substitute equipment or material in no way voids specification requirements.

B. Under no circumstances shall SCRRA be required to prove that an item proposed for substitution is not equal to the specified item. It shall be mandatory that the Contractor submits to SCRRA all evidence to support the contention that the item proposed for substitution is equal to the specified item. SCRRA’s decision as to the equality of substitution shall be final and without further recourse.

C. In the event that SCRRA is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if SCRRA is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the expenses in connection with such additional services shall be paid by the Contractor and may be deducted from any moneys owed to the Contractor.

D. If the deviation is not approved by SCRRA, it remains the Contractor’s responsibility to provide what is required in the Contract Documents.
1.07 SYSTEM DESCRIPTION

A. Furnish and install a fully-functional VSS as specified in the Contract Documents and as approved by SCRRRA personnel in accordance with established SCRRRA standards.

B. Drawings and layouts will depict the location of VSS equipment throughout the project site. Block and wiring diagrams shall show how VSS equipment should be interconnected. Information provided by the Authority may be general or conceptual, and may require the Contractor to undertake system design and functionality prior to installation.

C. All cameras in the VSS shall use TCP/IP protocol and be of the IP/network type. All cameras shall operate via PoE. Any existing analog cameras shall be removed, replaced with an IP/network camera, or connected to a video encoder for analog to digital signal conversion per SCRRRA approval.

D. IP/network cameras at each location shall communicate with a local NVR embedded with Milestone XProtect VMS for recording, local and remote management. Cameras shall connect to the NVR through its own dedicated VSS LAN consisting primarily of Ethernet switches and CAT-6 network cabling.

E. All video captured by the IP/Network cameras shall be recorded by the NVR. Per California Government Code Section 34090.8, recorded images shall be stored for at least one (1) year or 365 days prior to being written over.

F. Audit Trail: The VSS shall provide an audit trail of the recorded video to enable verification that the video has not been altered from date and time of recording. Video recordings must have the capability to be exported into a desirable media format that can easily be viewed using a standard PC with standard codec/media installed (e.g. Windows Media Player).

G. Other than the IP/network camera, all supporting VSS equipment shall be housed in a temperature controlled telecommunications room (e.g. station communications shelter, data center, server room, etc.), weatherproof enclosure, or air conditioned equipment cabinet (for locations without an existing telecommunications room).

H. All equipment in the VSS shall have surge protection and be connected to a UPS when available.

PART 2 - PRODUCTS

2.01 GENERAL

A. Unless otherwise specified, products for the VSS shall be consistent with and compatible with the established standards for SCRRRA VSS.

B. All network video products proposed shall conform to ONVIF Profile S.
C. When applicable, all products proposed for the VSS shall conform to ‘Buy America’ provisions.

D. The standard operating VMS for SCRRA is Milestone XProtect Professional (minimum). No exceptions.

E. All cameras shall be network (IP) cameras and will connect to an Ethernet switch as indicated in the Contract Documents.

F. SCRRA VSS camera types include the following: PTZ, 180-degree and 360-degree. Fixed cameras require SCRRA approval prior to installation.

G. See SCRRA Engineering Standard ES3604 for general camera mounting configurations.

H. All cameras shall have PoE functionality. PoE power for cameras shall originate from an IEEE 802.3at compliant, backwards compatible, PoE network switch or PoE mid-span injector.

I. All cameras shall have PoE surge protection. PoE surge protection shall typically be placed between the PoE network switch/mid-span injector and PoE network camera.

J. All cameras and VSS network cabling shall use outdoor-rated or plenum-rated CAT-6 UTP cable for signal transport, terminated with RJ45 connectors. Cable jacket color shall be white. Camera power and video signal shall be transported on the same cable.

K. PoE extenders can be used to extend a PoE connection beyond the 328 ft. (100 m) distance limitation. Up to one (1) PoE extender can be used to extend the PoE connection another 328 ft. (100 m), for a total cable length (from switch to camera) of 656 ft. (200 m).

L. Unless otherwise specified, all CAT-6 network cabling shall be installed from each camera back to a telecommunications room (e.g. station communications shelter, data center, server room, etc.), weatherproof enclosure, or air conditioned equipment cabinet (for locations without an existing telecommunications room).

M. For camera locations which cannot be supported by long distance PoE network connectivity, fiber optic cable and wireless Ethernet radio systems can be used as an alternative for camera data signal transport within the VSS LAN. These locations will be considered as “remote” camera locations within the VSS LAN. Use of these communication mediums requires SCRRA approval prior to installation.

N. Use of a NAS is permitted to fulfill the one (1) year or 365 days recorded image retention requirements per California Government Code Section 34090.8

O. All VSS equipment at the telecommunications room requiring building power shall connect to a UPS, dedicated to the VSS only.
P. Use camera mounting hardware as required from the product manufacturer.

Q. Programming, configuration, integration, start-up and commissioning of the VSS and associated elements shall be done in conjunction with SCRRA personnel.

R. All equipment shall be installed in accordance with this specification, applicable SCRRA engineering standards and manufacturer’s instructions. Provide, install and connect any and all equipment necessary to ensure a complete and working VSS as intended in the design. Any equipment such as consumables, terminators or any other materials or equipment needed to install this system shall be considered ancillary and be provided as part of this project. Contractor shall provide cable for all components of the VSS and integration of sub-systems. Cable shall be provided in accordance with manufacturer specification for the equipment it is terminating to.

2.02 CAMERA EQUIPMENT

A. Camera Compatibility: Cameras shall be compatible with SCRRA’s Video Surveillance System.

B. PTZ Dome Network Camera, Outdoor

1. Mounting Options (but not limited to):
   a. Pole mount
   b. Wall mount
   c. Corner mount
   d. Parapet mount
   e. Pendent mount

2. Automatic Day/Night Functionality

3. Minimum Illumination:
   a. Color: 0.2 lux at 30 IRE F1.4
   b. Black & White: 0.04 lux at 30 IRE F1.4

4. Digital Video Compression methods:
   a. H.264 Main and Baseline Profiles (MPEG-4 Part 10/AVC)
   b. Motion JPEG

5. Video Resolutions: 1280x720 (HDTV 720p) to 320x180

6. Frame Rate: no less than 30 frames per second for all required Digital Video Compression methods and Video Resolutions.
7. Video Streams: A minimum of three (3) simultaneous video streams shall be supported in all required Digital Video Compression methods.

8. Preset Positions: A minimum of 256 PTZ preset positions shall be supported, with a minimum accuracy of 0.5°.

9. Pan Movement:
   a. 360° continuous pan rotation
   b. 0.05° to 450° per second, minimum

10. Tilt Movement:
    a. 220°, minimum
    b. 0.05° to 450° per second, minimum
    c. Image shall auto-flip 180° at the bottom of the tilt travel

11. Zoom Capability:
    a. 30x optical zoom and 12x digital zoom for a total of 360x zoom, minimum
    b. Iris Control: Automatic with manual override
    c. Auto Focus shall be supported
    d. Electronic Image Stabilization (EIS) shall be supported
    e. Automatic defog filtering shall be supported

12. Dome cover color shall be “smoked”.

13. Camera shall be equipped with environmental housing suited for outdoor weather conditions and equipped with sunshield, fan and heater.

14. Axis Communications camera model Q6044-E, or approved equal.

C. Mini PTZ Dome Network Camera, Outdoor

1. Mounting Options (but not limited to):
   a. Wall surface mount
   b. Ceiling surface mount

2. IP66 rated enclosure and IK10 vandal resistance rating.

3. Minimum Illumination: 1.4 lux, F1.8
4. Digital Video Compression methods:
   a. H.264 (MPEG-4 Part 10/AVC)
   b. Motion JPEG
5. Video Resolutions: 1280x720 (HDTV 720p) to 320x180
6. Frame Rate: no less than 30 frames per second for all required Digital Video Compression methods and Video Resolutions.
7. Video Streams: Multiple and individually configurable streams in all required Digital Video Compression methods.
8. Preset Positions: A minimum of 25 PTZ preset positions shall be supported.
9. Pan Movement:
   a. 360° continuous pan rotation
   b. 100° per second, minimum
10. Tilt Movement:
    a. 90°, minimum
    b. 100° per second, minimum
11. Zoom Capability: 3x digital zoom, total 216x zoom
12. Dome cover shall be clear.
13. Axis Communications camera model M5014-V, or approved equal.

D. 180° and 360° Dome Network Camera, Outdoor
1. Mounting Options (but not limited to):
   a. Pole mount
   b. Wall surface mount
   c. Wall surface mount
   d. Ceiling surface mount
   e. Corner mount
   f. Parapet mount
   g. Pendent mount
2. Automatic Day/Night Functionality

3. Minimum Illumination:
   a. Color: 0.3-200000 lux, F2.0
   b. Black & White: 0.06 lux, F2.0

4. Digital Video Compression methods:
   a. H.264 Main and Baseline Profiles (MPEG-4 Part 10/AVC)
   b. Motion JPEG

5. Video Resolutions: 2592x1944 (5 MP) to 160x120

6. Frame Rate: no less than 12 frames per second with power line frequency (50/60 Hz) for all required Digital Video Compression methods and Video Resolutions.

7. Video Streams: A minimum of three (3) simultaneous video streams shall be supported in all required Digital Video Compression methods.

8. Angle of View: no less than 187° horizontal and 168° vertical

9. Camera Angle Adjustment: rotation +/−180°

10. Dome cover color shall be clear.

11. Camera shall be equipped with environmental housing suited for outdoor weather conditions and equipped with sunshield, fan and heater.

12. Axis Communications camera model M3027-PVE, or approved equal.

E. Fixed Dome Network Camera, Outdoor

1. Mounting Options (but not limited to):
   a. Pole mount
   b. Wall surface mount
   c. Wall surface Mount
   d. Ceiling surface mount
   e. Ceiling flush mount
   f. Corner mount
   g. Parapet mount
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VIDEO SURVEILLANCE SYSTEM (VSS)

2. Automatic Day/Night Functionality

3. Minimum Illumination:
   a. Color: 0.25 lux, F1.4
   b. Black & White: 0.05 lux, F1.4

4. Digital Video Compression methods:
   a. H.264 Main and Baseline Profiles (MPEG-4 Part 10/AVC)
   b. Motion JPEG

5. Video Resolutions: 1920x1080 to 160x90

6. Frame Rate: no less than 30 frames per second with power line frequency (50/60 Hz) for all required Digital Video Compression methods and Video Resolutions.

7. Video Streams: A minimum of three (3) simultaneous video streams shall be supported in all required Digital Video Compression methods.

8. Digital PTZ

9. Shutter Time: 1/142850 s to 2 s

10. Camera Angle Adjustment: Pan ±180°, tilt -5 to +75°, rotation ±95°

11. Dome cover color shall be clear.

12. Camera shall be equipped with environmental housing suited for outdoor weather conditions and equipped with sunshield, fan and heater.

13. Axis Communications camera model P3225-LVE, or approved equal.

F. Fixed Network Camera, Outdoor

1. Mounting Options (but not limited to):
   a. Pole mount
   b. Wall mount
   c. Corner mount
   d. Ceiling mount

2. Automatic Day/Night Functionality
3. Minimum Illumination:
   a. Color: 0.18 lux, F1.3
   b. Black & White: 0.04 lux, F1.3
4. Digital Video Compression methods:
   a. H.264 Main and Baseline Profiles (MPEG-4 Part 10/AVC)
   b. Motion JPEG
5. Video Resolutions: 1920x1200 to 160x90
6. Frame Rate: 60 fps maximum
7. Video Streams: A minimum of three (3) simultaneous video streams shall be supported in all required Digital Video Compression methods.
8. Digital PTZ
9. Shutter Time: 1/143000 s to 2 s
10. Horizontal Angle of View: 90° to 40°
11. Camera shall be equipped with environmental housing suited for outdoor weather conditions and equipped with sunshield, fan and heater.
12. Axis Communications camera model Q1615-E, or approved equal.

G. Fixed Thermal Network Camera, Outdoor
1. Mounting Options (but not limited to):
   a. Pole mount
   b. Wall mount
   c. Corner mount
   d. Ceiling mount
2. Automatic Day/Night Functionality
3. Sensitivity: Noise Equivalent Temperature Difference (NETD) less than 75 mK
4. Digital Video Compression methods:
   a. H.264 Main and Baseline Profiles (MPEG-4 Part 10/AVC)
   b. Motion JPEG
5. Video Resolutions: Up to 640x480
6. Frame Rate: Up to 30 fps
7. Detection Range: Up to 3500 yards for a vehicle in ideal weather conditions
8. Video Streams: A minimum of three (3) simultaneous video streams shall be supported in all required Digital Video Compression methods.
9. Horizontal Angle of View: 57° to 18°
10. Camera shall be equipped with environmental housing suited for outdoor weather conditions.
11. Axis Communications camera model Q1932-E, or approved equal.

2.03 NETWORK VIDEO RECORDER (NVR)
   A. High performance NVR with built-in Windows Embedded Standard 7 (minimum), and pre-installed and licensed version of Milestone XProtect VMS that supports Milestone Mobile functionality.
   B. Allows a minimum of 20 camera connections at the same time for live-viewing and recording via 1Gbps Ethernet port with included camera license, and can be extended to allow additional camera connections by adopting an “additional camera license” that can be purchased separately.
   C. A second, or additional, 1 Gbps Ethernet port for video distribution to client PCs.
   D. General:
      1. Suitable for standalone configuration for basic surveillance system
      2. Suitable for master/slave configuration for larger surveillance system
      3. Suitable for 24/7 surveillance based on 49,000 hour MTBF
      4. Suitable to be rack-mounted or mounted in an equipment rack utilizing a customizable mounting solution.
   E. Recorder Hardware:
      1. CPU: Intel Core i5 minimum
      2. RAM: 4GB minimum
   F. Supported Video CODECs:
      1. H.264
      2. Motion JPEG (MJPEG)
3. MPEG-4

G. Storage Components:
   1. SSD and/or HDD
   2. 2TB total storage minimum

H. Recorded Data Export:
   1. Export Media: USB memory, CD-R/RW or DVD-R/RW (via USB external)
   2. Export Format: AVI (video), JPEG (still image), Milestone XProtect Enterprise Database format (internal format)

I. Playback Function:
   1. Normal playback
   2. Slow playback
   3. Fast playback
   4. Fast forward and reverse
   5. Frame-by-frame playback

J. Database Search Key:
   1. Time/data search
   2. Alarm search
   3. Smart Search (motion detection on playback video)

K. Client Workstation Requirements: The VMS client software, or remote-viewing PC, shall operate on the following minimum required hardware:
   1. OS: Microsoft Windows 7 Professional SP1 (32-bit or 64-bit) minimum
   2. CPU: Intel Core2 Duo, 2.4GHz or higher
   3. RAM: 1GB (minimum)
   4. Network: 100Mbps or higher
   5. Graphics Card: AGP or PCI-Express, minimum 1280 x 1024, 16-bit colors
   6. HDD: Minimum 1GB free space for installation
   7. Software: DirectX 9.0 or newer required to run Playback Viewer application; Microsoft.Net 4.5.1 Framework
L. Electrical:
   1. Input voltage: 200W / 100~240V

M. Environmental:
   1. Operation Temperature: 0~40°C
   2. Storage Temperature: -20°C~70°C

N. Mechanical:
   1. One (1) – 1 Gbps dual network interface card with RJ45 ports (auto negotiation)
   2. Four (4) – USB 2.0 ports (minimum)
   3. One (1) – DVI / VGA port
   4. One (1) – HDMI port
   5. One (1) – Audio in mini jack
   6. One (1) – Audio out mini jack
   7. Three (3) – COM ports

O. Milestone Husky M30 or M50, or approved equal.

2.04 RUGGEDIZED NVR

A. Rugged, high performance NVR with built-in Windows Embedded Standard 7 (minimum) and preloaded with Milestone XProtect VMS that supports Milestone Mobile functionality.

B. NVR shall be built to operate reliably in harsh usage environments and conditions such as strong vibrations, extreme temperatures and dusty conditions.

C. NVR shall employ a compact, hardened, fully fanless and ventless chassis design for protection against dirt dust, tampering, strong vibrations and extreme temperatures.

D. NVR shall allow a minimum of 25 camera connections at the same time for live-viewing and recording via 1Gbps Ethernet port.

E. NVR shall include a second 1Gbps Ethernet port for video distribution to client PCs.

F. General:
   1. Suitable for standalone configuration for basic surveillance system
2. Suitable for master/slave configuration for larger surveillance system
3. Suitable for 24/7 surveillance
4. Suitable for wall-mounting and placement in small spaces

G. Recorder Hardware:
1. CPU: 2.3GHz Intel Core i7-4770TE minimum
2. RAM: 8GB, DDR3 minimum

H. Supported Video CODECs:
1. H.264
2. Motion JPEG (MJPEG)
3. MPEG-4

I. Storage Components:
1. SSD only
2. 2TB total storage minimum
3. 0~70°C operating temperature

J. Recorded Data Export:
1. Export Media: USB memory, CD-R/RW or DVD-R/RW (via USB external)
2. Export Format: AVI (video), JPEG (still image), Milestone XProtect Enterprise Database format (internal format)

K. Playback Function:
1. Normal playback
2. Slow playback
3. Fast playback
4. Fast forward and reverse
5. Frame-by-frame playback

L. Database Search Key:
1. Time/data search
2. Alarm search
3. Smart Search (motion detection on playback video)

M. Client Workstation Requirements: The VMS client software, or remote-viewing PC, shall operate on the following minimum required hardware:

1. OS: Microsoft Windows 7 Professional SP1 (32-bit or 64-bit) minimum
2. CPU: Intel Core2 Duo, 2.4GHz or higher
3. RAM: 1GB (minimum)
4. Network: 100Mbps or higher
5. Graphics Card: AGP or PCI-Express, minimum 1280 x 1024, 16-bit colors
6. HDD: Minimum 1GB free space for installation
7. Software: DirectX 9.0 or newer required to run Playback Viewer application; Microsoft.Net 4.5.1 Framework

N. Electrical:

1. Input voltage: 9~48V
2. Power Input: 3-Pin Terminal Block Connector

O. Environmental:

1. Operation Temperature: 0~60°C

P. Mechanical:

1. Two (2) – 1Gbps LAN port (auto negotiation; minimum)
2. Four (4) - 802.3af PoE port (minimum)
3. Four (4) – USB 2.0 port (minimum)
4. Four (4) – USB 3.0 port (minimum)
5. Two (2) – DisplayPort (minimum)
6. One (1) – DVI-I port (minimum)
7. Two (2) – Audio jack: One (1) line-in, One (1) mic-out (minimum)
8. Six (6) – RS-232/422/485 COM port (minimum)
9. One (1) – 4 Input / 4 Output Isolated DIO port (minimum)
10. One (1) – PS/2 port for keyboard/mouse (minimum)
11. One (1) – 2.5” Hot-Swap HDD/SDD bay (minimum)
12. One (1) – SIM Card slot
13. NVR dimensions shall not exceed 10.2-in W x 4.2-in H x 10.3-in D
Q. Milestone MX1000 Rugged In-Vehicle NVR by Logic Supply, or approved equal.

### 2.05 NETWORK ATTACHED STORAGE (NAS)

A. Processor: Quad-core Intel Celeron 2.0GHz (up to 2.41GHz)

B. Memory:
   1. Preinstalled with one (1) 4GB DDR3L SDRAM
   2. Minimum of two (2) SODIMM slots that can support up to 8GB

C. Flash Memory: 512MB

D. Internal Drive:
   1. Minimum of four (4) hard drive bays that can support 3.5” or 2.5” SATA 6Gb/s HDDs
   2. HDD: 4TB minimum (each), minimum of four (4) HDD required

E. Form Factor: 1U, rack mountable

F. Network Interface: four (4) RJ45 Gigabit Ethernet ports

G. Ports:
   1. Five (5) USB 3.0, minimum
   2. One (1) HDMI, minimum
   3. One (1) Console (for system maintenance)

H. Electrical:
   1. Input voltage: AC 120V – AC 240V (50 Hz / 60 Hz)
   2. Output voltage: 250W

I. Operating Temperature Range: 32°F (0°C) - 104°F (40°C)

J. Relative humidity of up to 95%, non-condensing

K. Operating System: embedded Linux

L. Dimensions shall not exceed 1.75-in H x 17.3-in W x 19.7-in D
M. QNAP Systems, Inc. TS-453U with compatible HDDs, or approved equal.

2.06 CABLES, CONNECTORS AND PATHWAYS

A. Category 6 (CAT-6) Cable:
   1. The ANSI/TIA/EIA standard for Category 6 cable is TIA/EIA 568-5-B.2-10.
   2. The maximum length for a cable segment is 328 feet (100 meters). If longer runs are required, the use of active hardware (e.g. extender, repeater, switch) is required.
   3. Cable jacket color shall be white.
   4. Belden 2412, or approved equal.

B. RJ45 Connector (for CAT-6 Cable):
   1. Registered Jack-45, an eight-wire connector used commonly to connect computers onto networks.
   2. Contractor shall use EZ-RJ style connectors with strain relief (p/n: PLAT-202015J or equivalent).

C. Pathways and Raceways:
   1. Pathways and raceways are shown in the Electrical drawings to provide cable and power conduit pathways for equipment included for the Video Surveillance system.
   2. Contractor to verify pathways and raceways, and calculate lengths for cable runs.
   3. Conduit shall be supplied as a system from a single manufacturer providing all specified conduit types; all required fittings, terminations and other installation accessories; all in accordance with applicable SCRRA Engineering Standards, manufacturer’s instructions and Contract Documents.
   4. All new conduit shall be free from defects, including non-circularity, foreign inclusions, etc. It shall be uniform in color, density and physical properties. It shall be straight and the ends shall be cut square to the inside diameter.
   5. All new conduit shall display the Underwriters Laboratory certification (UL Listed).
   6. All new conduit shall meet the requirements of Section 26 13 00 - Raceways and Boxes.
2.07 POWER-OVER-ETHERNET (POE) EQUIPMENT

A. PoE Midspan:

1. For cameras requiring IEEE 802.3af or IEEE 802.3at PoE power, furnish and install new rack-mount PoE midspan power injectors in equipment racks, as required. Camera manufacturer provided single-port PoE midspan power injector can be used in lieu of rack-mount injector per SCRRA approval. Contractor responsible for mounting configuration of single-port PoE midspan power injector in telecommunications room.

2. Port Configuration: no less than eight (8) ports of IEEE 802.3af and IEEE 802.3at compliant PoE for 10/100/1000 Base-T networks.

3. Output power: 52VDC, 37W Max per Port

4. Status indicating LEDs for output and power.

5. Comnet CopperLine model CLFE8IPS, or approved equal.

B. PoE Extender:

1. Furnish and install new PoE extenders, as required. Up to one (1) PoE extender can be used to extend a PoE connection another 328 ft. (100 m), for a total cable length (from switch to camera) of 656 ft. (200 m).

2. Environmental:
   a. IP66 rated enclosure for external installation
   b. Operating temperature range of -40°F to 140°F
   c. Relative humidity of up to 85%, non-condensing

3. Power Consumption: 1.3W via PoE

4. PoE Standards: IEEE 802.3af, IEEE 802.3at and custom PoE up to 60W

5. Ethernet Interface: two (2) independently auto-configuring 10/100 ports (10BASE-T/1000BASE-TX, half/full duplex) with patch or crossover cables supported

6. Status indicating LEDs for PoE power and Ethernet link/activity

7. Veracity Outreach Max XT model VOR-ORM-XT, or approved equal.

C. PoE Surge Protector:

1. Furnish and install new PoE surge protectors, as required. PoE surge protectors can be rack mount (for multiple ports) or surface mount (for single port).
2. **Rack Mount (Multiple-Port) PoE Surge Protector:**
   a. Port Configuration: no less than twelve (12) RJ45 in/out ports
   b. Supports gigabit Ethernet data speed
   c. PoE Standards: IEEE 802.3af, IEEE 802.3at and high wattage PoE Plus
   d. Operating temperature range of -40°F to 158°F
   e. Relative humidity of up to 95%, non-condensing
   f. Housing: galvanneal sheet metal
   g. One (1) rack unit (U) high
   h. Ditek Corporation model DTK-RM12POE, or approved equal.

3. **Single-Port PoE Surge Protector:**
   a. Port Configuration: one (1) RJ45 in/out port
   b. Supports gigabit Ethernet data speed
   c. PoE Standards: IEEE 802.3af, IEEE 802.3at and high wattage PoE Plus
   d. Operating temperature range of -40°F to 158°F
   e. Relative humidity of up to 95%, non-condensing
   f. Housing: ABS
   g. Ditek Corporation model DTK-MRJPOE, or approved equal.

### 2.08 ETHERNET SWITCH

#### A. Power-over-Ethernet (PoE) Aggregation Switch:

1. PoE switch shall have 24 RJ45 auto-negotiating 10/100/100 PoE Ports + 4 SFP 1000 Mbps ports.
2. Two (2) 1000 Mbps (1 Gigabit) multimode SFP transceivers required.
3. Switch shall be rack-mountable.
4. Switch shall support jumbo frames and have a switching capacity of 56 Gbps and forwarding performance of up to 41.7 Mpps (64-byte packets).
5. Other requirements shall include; flow control, full duplex, and layer 3 switching, auto-sensing per device and VLAN support.
6. Electrical: switch shall have 120-240 VAC internal power supply.
7. Environmental: Operating temperature range of 32°F to 113°F.
8. HP 1910-24G-PoE (365 W) with compatible SFP transceivers, or approved equal.

B. 7-Port PoE Switch:
1. The 7-port PoE switch shall be a PoE PSE (Power Sourcing Equipment) that powers remote PoE cameras.
2. The 7-port PoE switch shall be unmanaged.
3. The switch housing shall be metal with an IP30 protection rating.
4. The 7-port PoE switch shall have five (5) 10/100Tx RJ45 ports.
5. The 7-port PoE switch shall include two (2) 100/1000 SFP slots.
6. Two (2) 1000 Mbps (1 Gigabit) multimode SFP transceivers required.
7. The switch shall have four (4) RJ45 ports that support 802.3at PoE+.
8. The switch shall have the capability to extend network connectivity up to 1.2 miles (2 kilometers) over multimode fiber.
9. Electrical:
   a. 7-port PoE switch shall accept an input voltage in the range of 48VDC and 55VDC.
   b. Contractor to determine power requirements for switch. If necessary, furnish and install separate power supply for switch. Separate power supply to be DIN rail mounted.
10. Environmental: Standard operating temperature range of -10°C to 70°C; extended operating temperature range of -40°C to 75°C.
11. Antaira LNP-0702C-SFP-T with compatible SFP transceivers, or approved equal.

2.09 TELECOMMUNICATIONS ROOM EQUIPMENT
A. Keyboard-Video-Mouse (KVM) Rack Console & Cable Assembly
1. General:
   a. Rack-mountable
   b. Built-in KVM switch with a minimum of eight (8) ports
c. Laptop style keyboard and touch pad style mouse with PS/2 and USB connections available

d. Viewing angle: 170° vertical, 178° horizontal

2. Display:

a. 19” LCD widescreen

b. Maximum resolution of 1440 x 900

c. Analog and VGA display connections available

d. Color depth of 16.7M

e. Aspect ratio of 16:9

f. Pixel pitch of 0.2835

3. Environmental:

a. Operating temperature range of 32°F to 104°F

b. Relative humidity of up to 80%, non-condensing

c. Storage temperature range of -4°F to 140°F

4. Built-in power supply with auto-switching 100 to 240VAC, 50 to 60Hz, 48 Watt power rating

5. KVM cable assembly shall be from the same manufacturer as the KVM rack console provided. Contractor to verify that manufacturer provided cable matches KVM port configuration of NVR. If not, contractor to furnish and install new KVM cable assembly to match KVM port configuration of NVR. Consult manufacturer for cable assembly selection type.

6. Belkin F1DC108H, or approved equal.

B. Uninterruptable Power Supply (UPS)

1. The UPS shall be rack mountable. The UPS shall provide temporary electrical backup for PoE cameras, servers and switches associated with the VSS.

2. Minimum requirements for the UPS:

a. Capacity: 1440VA / 1440 Watts

b. Input: 120V

c. Output: 240V
d. Two (2) rack unit (U) high

3. Connection requirements for the UPS:
   a. Input connection: one (1) NEMA 5-15P input plug
   b. Output connections: eight (8) NEMA 5-15R output receptacles

4. Extended battery modules shall be provided.
   a. Output: 48V
   b. Minimum of two (2) extended battery modules required per UPS
   c. Extended battery modules shall be rack mountable
   d. Two (2) rack unit (U) high

5. UPS: Eaton 5PX1500RT, or approved equal.

6. Extended Battery Module: Eaton 5PXEBM48RT, or approved equal.

C. Equipment Rack

1. The width of the equipment mounting-frame in the equipment rack shall be 19-inches (unless otherwise specified).

2. Floor Mounted:
   a. Floor mounted equipment racks in the specified telecommunications room shall be EIA compliant.
   b. Fully welded construction shall provide a static capacity of 10,000 lbs. and a UL Listed load capacity of 2,500 lbs.
   c. Rack shall be constructed of the following materials: top and bottom shall be 14-gauge steel, horizontal braces shall be 16-gauge steel and all structural elements shall be finished in a durable black powder coat.
   d. Racks shall have ventilated locking front and rear doors.
   e. Middle Atlantic Products MRK-4436, or approved equal.

3. Wall Mounted:
   a. Wall mounted equipment racks in the specified telecommunications room shall be EIA compliant.
   b. Rack construction shall provide a minimum UL Listed capacity of 250 lbs.
c. Rack shall be constructed of 16-gauge steel, phosphate pre-treated and finished in a black textured powder coat.

d. Rackrail shall be constructed of 11-gauge steel with tapped 12-24 mounting holes in universal EIA spacing with black powder coat finish.

e. Rack shall feature a locking swing open center section for front and rear access.

f. Rack shall include a locking/latching plexi front door for added security.

g. Middle Atlantic Products CWR-12-22PD, or approved equal.

2.10 WEATHERPROOF ENCLOSURE

A. Mounting Options:

1. Pole mount

2. Wall mount

B. The weatherproof enclosure shall be a molded fiberglass reinforced polyester (FRP) industrial enclosure.

C. The cases shall have quick release latches with padlock hasps.

D. NEMA Type 3R, 3RX with an IP24 protection rating.

E. The weatherproof enclosure shall include mounting plate, duplex 120 VAC outlet and thermostat controlled cooling system.

F. The weatherproof enclosure shall have one (1) ½-inch conduit connector for power and two (2) 1-inch conduit connectors for data/signal.

G. The weatherproof enclosure exterior dimensions shall not exceed: 19.5-in. x 17.5-in. x 10-in.

H. L-Com NB181608-40FSAF, or approved equal.

2.11 OUTDOOR AIR CONDITIONED EQUIPMENT CABINET

A. Outdoor air conditioned equipment cabinet shall consist of the cabinet assembly, rack-mounted air conditioner, cabinet foundation and all materials, components, appropriate connectors, tools, equipment and incidentals necessary for a fully-functional air conditioned equipment cabinet.

B. Cabinet shall meet the requirements of the model 334 traffic controller cabinet standard used by the State of California Department of Transportation (Caltrans).

C. Cabinet outside dimensions shall not exceed 67-in H x 25-in W x 38-in D.
D. Cabinet shall be constructed with 5052-H32 aluminum, 0.125-in thick.

E. Cabinet interior shall be entirely insulated with airtight seals.

F. Cabinet shall have two full size (2) doors for access: one (1) for front and one (1) for rear of cabinet. Both doors shall be louvered for air conditioning ventilation and include door stops.

G. Cabinet door handles shall be stainless steel, ¾-in round, with provisions for a padlock.

H. Cabinet shall include an electrical service panel assembly, and a minimum of one (1) 30-amp circuit breaker and one (1) 20-amp NEMA 5-20 receptacle.

I. Cabinet shall include a removable 19-in EIA rack assembly.

J. Cabinet foundation per Caltrans 2010 Standard Plan ES-3C, Detail D.

K. Rack-mounted air conditioner:
   1. Cooling capacity: 3500 BTU/H
   2. 95/95 Rating: 2700 BTU/H
   3. Maximum Ambient Temperature: 125°F
   4. Minimum Ambient Temperature: 50°F
   5. Power: 115/100 VAC, 60/50 Hz; 3-wire power cord
   6. Thermostatically controlled
   7. Refrigerant: CFC-free R134a
   8. EIA-notched flanges for mounting in a 19-in EIA rack.
   9. Compatible with cabinet assembly.

L. Cabinet Assembly: McCain, Inc. Air Conditioned Equipment Cabinet, 332/334 Style, or approved equal.

M. Rack-Mounted Air Conditioner: Kooltronic, Inc. KA4C3.5H9R, or approved equal.

2.12 FIBER OPTIC COMMUNICATION SYSTEM

A. See Section 26 12 00 - Conductors and Cables - Low Voltage, for fiber optic cable requirements.

B. See Section 29 20 20 - Communications Services and Section 34 44 12 - Customer Information System (CIS), for all fiber optic communication system components and requirements.
C. Fiber Optic Patch Panel (FOPP)

1. Inside the telecommunications room, fiber optic cable shall be terminated onto a fully-functional, 19-inch rack mounted FOPP (aka fiber distribution unit) that shall include connector housing, brackets, connectors and splice trays as specified and as shown on the Contract Documents.

2. For remote camera locations, fiber optic cable shall be terminated onto a FOPP that shall include a single-panel connector housing, brackets, connectors and splice trays as specified and as shown on the Contract Documents. FOPP must be securely mounted inside weatherproof enclosure and must fit inside enclosure with other applicable VSS equipment and components.

D. Subject to conformance with the requirements of this Section, use products manufactured by Corning, Inc.

2.13 WIRELESS ETHERNET RADIO COMMUNICATION SYSTEM

A. The wireless Ethernet radio system shall consist of all materials, components, appropriate connectors, tools, equipment and incidentals necessary to establish a wireless link to camera locations (beyond PoE distance limits) within the VSS LAN.

B. The wireless Ethernet radio system shall meet the minimum requirements:

1. 5.8 GHz broadband Ethernet radio
2. Dynamic frequency selection
3. 802.11 b/g compliant with up to 54 Mbps data throughput
4. Minimum of 2x2 MIMO operation
5. Each radio must be capable of operating in Point-to-Point and Point-to-Multipoint modes
6. Server-less architecture with web-based interface for remote management, troubleshooting, monitoring, and configuring the wireless network in real time, without additional hardware or software.
7. Multiple Ethernet Ports
8. VOIP and PTZ control traffic prioritized over other traffic (for better latency)
9. Multicast route and forward support
10. Built-in spectrum analyzer
11. Built-in real-time bandwidth monitoring tools
12. Environmentally hardened outdoor units
13. Low profile design

C. Subject to conformance with the requirements of this Section, use products manufactured by Ubiquiti Networks, Inc. or approved equal.

2.14 POLE MOUNTED SOLAR POWER SUPPLY SYSTEM

A. The pole mounted solar power supply system shall consist of all materials, components, appropriate connectors, tools, equipment and incidentals necessary to establish an "off-grid" power source to camera locations.

B. All materials furnished, assembled, fabricated or installed shall be new, corrosion resistant and rated for outdoor use.

C. Pole mounted solar power supply system shall be side-pole mounted unless otherwise specified.

D. The pole mounted solar power supply system shall generally consist of the following components:

1. Solar panel(s) and mounting hardware
2. Weatherproof enclosure and mounting hardware
3. Battery bank
4. Battery charge controller
5. Internal and external wiring cables and conductors

E. The pole mounted solar power system shall meet the minimum requirements:

1. Solar Panel:
   a. Provide 12VDC
   b. Wattage Output: 100 watts (minimum acceptable)
   c. Dimensions shall not exceed 61-in x 54-in

2. Weatherproof Enclosure:
   a. Shall be of powder coated steel construction
   b. Space available inside enclosure for placement of additional electronic hardware
   c. Include DIN mounting rails inside of enclosure
   d. Dimensions shall not exceed 25-in x 15-in x 15-in

3. Battery (for Battery Bank):
a. Battery nominal voltage: 12VDC
b. Battery capacity: 100 amp-hour
c. Battery type: Valve Regulated Sealed Lead Acid / GEL
d. Battery Life: 5 Years
e. Sized to allow one (1) day of autonomy

4. Battery Charge Controller:
   a. Provide fully operational control of the battery charging process and solar panel effects.
   b. Controller type: Pulse Width Modulation (PWM)
   c. Solid state construction
d. Support 12VDC
e. Provide protection against over-charging and over-discharging of battery bank
   f. Load inputs for solar and PoE power sources
g. Load outputs via PoE and auxiliary wire terminal
   h. Power consumption: 0.5 watts maximum

5. Operating temperature of -30°C to +60°C (-22°F to 140°F)

6. Wind speed rating of 90 miles per hour

F. Subject to conformance with the requirements of this Section, use products manufactured by Tycon Systems, Inc. or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Cameras shall be mounted in locations as shown in the Contract Documents and/or approved by SCRRRA.

B. Install all system components, including furnished equipment, and appurtenances in accordance with the manufacturer’s instructions, and as shown, and shall furnish all necessary interconnections, services, and adjustments required for a complete and operable system as specified and shown. Control signal, communications, and data transmission line grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.
C. Cameras accessible to the public shall be concealed or placed in protective, tamper-proof environmental enclosures and surface mounted beyond a person’s normal reach at a minimum of 10 feet above ground level (unless otherwise indicated).

D. Cameras shall be located so that their Field of View (FOV) is not restricted by other station installations such as walls, ceilings, columns, signs, and luminaries. Plans demonstrating the unobstructed FOV of each camera shall be submitted for SCRRRA review.

E. Cameras shall be located so that they never directly view the sun. The FOV of cameras shall be adequately illuminated either by natural light or by luminaries. Within the FOV, particular care shall be taken to avoid extremes of light and shadow.

F. Equipment enclosures and other video surveillance equipment installed at locations accessible to the public shall be mounted using tamper-proof mounting hardware and beyond a person’s normal reach at a minimum of 10 feet above ground level (unless otherwise indicated).

G. Mounts for camera shall be designed to support loads of 25 pounds minimum.

H. Pole Mounts used for outside cameras shall use custom mounts. Coordination with architect and SCRRRA for style and color may be required. All parts shall be protected from corrosion, including insulation against dissimilar metals.

I. Contractor shall use existing conduit and surface raceway where possible and practicable. All work shall be concealed using existing facility infrastructure throughout project site. If concealment is impossible or impractical, SCRRRA shall be notified before starting that part of the work.

J. Where required, Contractor shall be responsible for cutting, patching, coring and associated work for the system at no additional cost to the Owner.

K. Provide easy, safe, and mandated clearances at equipment racks and enclosures, and other equipment requiring maintenance and operation. All telecommunications room equipment racks shall be mounted a minimum of 36-inches from the wall or other cabinets, equipment or power panels. SCRRRA to review and approve all equipment mounting locations and configurations inside telecommunications room prior to installation.

L. All cables and patch cables shall have a label attached at both ends. All equipment components shall have a label specifying pertinent information and shall be clearly visible on the exterior of equipment. Contractor shall confirm specific labeling requirements with SCRRRA prior to cable installation or termination, and equipment installation.

M. For remote camera locations requiring electrical power, splice into existing power circuit wherever possible. Splice points to occur in the nearest pull box at each remote camera location. Consult with existing power circuit owner prior to splicing. Splices into existing CIS power circuit require SCRRRA approval.
3.02 TESTING

A. Factory and field testing shall be performed in accordance with SCRRRA Standard Specification 01 91 13 - General Commissioning Requirements.

B. Factory Tests: Perform factory test of each camera type to demonstrate correct operation as defined in these Specifications.

C. Field Tests: Perform cable tests as indicated in the approved test plan. Furnish all equipment, appliances, and labor necessary to test the installed cable mediums throughout the VSS.

1. Perform continuity tests on CAT-6 camera cables using a meter having a minimum input resistance of 20,000 ohms per volt. Show that each conductor has a resistance of not more than 16 ohms per 1000 FT of conductor run.

2. Perform continuity test on fiber cables. Fiber cables need to be tested three (3) times:
   a. A continuity test of the fiber shall be performed before installation. Fiber cable shall be tested on the cable reel for continuity prior to installation.
   b. Next continuity test shall be performed after installation and before termination for insertion loss of each installed segment.
   c. The final continuity test shall be a complete end to end test using LED sources and documenting each fiber cables result.

3. Perform all continuity testing after final termination (except fiber cable) and cable installation, but prior to connection of any electronics or field devices.

4. Replace any cable that fails to meet the parameters, or if any testing reveals defects in the cable. Retest new cable as specified above.

5. Contractor to furnish their own test equipment.

6. Furnish all test results to SCRRRA.

D. Perform the following local field operations tests on site in accordance with an SCRRRA approved field test plan. Demonstrate the following after the camera controller assemblies, other camera hardware, power supplies and connecting cabling have been installed:

1. Verify physical construction has been completed in accordance with the contract plans and specifications.

2. Inspect quality and tightness of all connections (power and data) throughout the VSS.
3. Check power supply voltages and output.
4. Connect devices to power sources.
5. Verify installation of all cables and connections to ensure intended operations.

3.03 COMMISSIONING

A. Commissioning is the process by which the Contractor will demonstrate to SCRRA that it has completed the project in conformance with the contract documents and that the project will perform as specified in the contract documents.

B. The Contractor shall be Manufacturer certified and solely responsible for providing all test and commissioning equipment, tools, software, programming, programming support and incidentals and qualified technicians to start-up, calibrate, debug and verify proper function of the systems and subsystems as required by the Commissioning Plan.

C. The responsibilities of the Contractor during commissioning shall be to assign representatives with expertise and authority to act on its behalf, and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

1. Evaluate performance deficiencies identified in test reports and, in collaboration with the entity responsible for system and equipment installation, recommend corrective action.
2. Resolve issues recorded in the test reports.
3. Organize and lead the commissioning team and coordinate commissioning process activities with the construction schedule.
4. Review and accept checklists provided by the construction manager or SCRRA. Complete checklists as work is completed, and provide them to the construction manager or SCRRA on a daily basis.
5. Complete commissioning process test procedures including specific construction checklists and commissioning process test procedures.
6. Contractor shall witness systems, assemblies, equipment, and component start-up. Compile test data, inspection reports, and certificates; include them in the printed systems manual and commissioning process report.

3.04 CLOSEOUT ACTIVITIES AND ACCEPTANCE

A. Completion of successful installation, final tests and commissioning, receipt of the test reports and as-built documentation, and successful performance of the installed equipment and system for a thirty (30) day period will constitute Final Acceptance.
PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Video Surveillance System (VSS) will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Video Surveillance System furnished and completed in accordance with the Contract Documents will be paid for as a lump sum. This price shall be full compensation for furnishing all labor, materials, tools, equipment, supplies, supervision and incidentals necessary for the Video Surveillance system including multiple types of cameras, camera mounts and housings, cabling/connectors, intermediate connectivity devices, Network Video Recorders, and furnishings described by the Contract Documents.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. The Customer Information System (CIS) will include: PA, LED message signs, Personal Computer (PC), Liquid Crystal Display (LCD) Monitor(s), Strobe lights on each LED message sign, power supplies, cables, wires, connectors, miscellaneous equipment such as mounting posts, brackets, enclosures, media converters, and switches. The CIS will interface with the SCRRA network through Multiprotocol Label Switching (MPLS) router.

B. Detailed requirements and detailed Statement of Work including the equipment requirements for CIS are identified in Section 29 20 20, Communications Services.

C. This SOW includes Work to be performed by the Contractor. The Work includes furnishing, installing, testing and upgrading the PA/CMS system on existing stations to CIS and installing CIS on the new stations. The Work shall be performed as specified in this document and in the station specific Specifications, materials list, and Plans. A general summary of the SOW is included in this section, with details included in Section 29 20 20, Communications Services. This document and accompanying materials form the Standard Plans, Standard Materials List, and Standard Specifications.

1. The Contractor shall provide final Shop Drawings and shall submit them to SCRRA for review and Approval. The Plans shall include all details of equipment installation, wiring, cabling, equipment interconnection, and rack mounting of equipment, materials list, and cut sheets of the equipment to be installed. Upon review, SCRRA may Approve, Conditionally Approve, or may Disapprove the Plans. If Conditionally Approved or Disapproved, the Contractor shall correct the deficiencies within a reasonable time and shall submit the Plans to SCRRA for final Approval.

2. Upon Approval of final Shop Drawings the Contractor shall seek Approval from SCRRA for equipment procurement in writing. The SCRRA may request different equipment or Approved equal from those listed in the materials list prior to ordering the equipment. Upon Approval from the SCRRA, for equipment procurement the Contractor shall develop final Shop Drawings which shall include but shall not be limited to wiring diagrams, equipment assembly and installation, cable routing, and all equipment interfaces including rack layout. The Contractor shall submit these Plans to SCRRA for review and Approval prior to installing any equipment. All comments by SCRRA on the previous revisions and the preliminary Plans shall be resolved in the final shop drawings. Upon review, SCRRA may Approve, Conditionally Approve, or Disapprove the
Plans. If Conditionally Approved or Disapproved, the Contractor shall correct any deficiencies until the Plans are Approved. Only after Approval of Plans and Approval from SCRRA to procure equipment the Contractor shall proceed to procure the necessary equipment. The Contractor shall seek Approval from SCRRA to install the indicated equipment. Upon completion of installation the Contractor shall seek Approval from SCRRA to test all equipment specified in this SOW. Installation shall comply with these Standard Specifications, associated Standard Plans, and Standard Materials List. The Contractor shall also comply with all other SCRRA documents such as site specific Station CIS Installation Design, Design Criteria, Communications and Signaling Design, and other Standard Plans. The Contractor shall provide all equipment and labor for this Work with no additional cost to SCRRA. At any stage, if the Plans, installations, or test process or test results are disapproved by SCRRA, the Contractor shall correct all deficiencies within reasonable time at no additional cost to SCRRA and if necessary re-install the equipment. If necessary, the Contractor shall re-test the equipment. These activities shall be completed with no additional cost to SCRRA.

3. CIS shall include, but not limited to: ethernet switch, rack mounted media converters, rack mounted fiber patch panel, amplifier(s), audio decoder, priority controller, Emergency Management Panel (EMP), LED message signs, strobe lights, cables, and connectors. 42-inch LCD monitor(s) with an embedded Network Media Player (NMP) shall be also installed in area(s) indicated on the Plans to display train schedule.

4. As indicated in this document and the Plans, the Contractor shall use the existing cables where appropriate or pull additional cables as required, remove existing equipment as indicated herein and install the new equipment. If the Contractor proposes any change including but not limited to change in equipment; installing additional equipment; adding conduits, pull boxes, junction boxes, the Contractor shall submit a change request in writing to SCRRA. The change request shall include the following as a minimum:

a. Base arrangement or configuration
b. Details of proposed change and reason for change request
c. Impact of change on other equipment and/or systems
d. Impact of change on architecture or structure
e. Other impacts due to the change

D. The Contractor shall not proceed with any changes without written Approval by SCRRA.

1. LCD monitor(s) shall be installed either on stand-alone posts or on existing structures. For installing the LCD monitor(s) on stand-alone post(s), the Contractor shall prepare site including required conduit
stubups, pour concrete and install posts as specified here and shown in the Plans. The LCD monitor(s) shall be mounted either on the post(s) or on the canopy structure.

2. Upon completion of installation and testing, the Contractor shall provide SCRRRA five (5) sets of as-built Plans in hard copies and three (3) sets of electronic copies on Compact Discs (CDs). The as-built Plans shall reflect the actual conditions of equipment installations in the field. If the supplied set of Plans does not show all the equipment and/or the necessary configurations, SCRRRA may request additional as-built Plans from the Contractor.

E. Related Specification Sections include but are not limited to:

1. Section 26 05 00 – Basic Electrical Material and Methods
2. Section 26 05 43 – Electric: Exterior Underground
3. Section 26 06 00 – Grounding and Bonding
4. Section 26 12 00 – Conductors and Cables – Low Voltage
5. Section 26 13 00 – Conduits, Raceways, and Boxes
6. Section 29 00 20 – Standards, Abbreviations, and Definitions (CIS)
7. Section 29 10 60 – Power Distribution Testing and Commissioning
8. Section 29 20 20 - Communications Services
9. Section 29 20 60 - System Testing And Commissioning

PART 2 – PRODUCTS

2.01 MATERIALS

A. SCRRRA will provide a Materials List of equipment to the Contractor for major CIS equipment. Based on the Materials List the Contractor shall procure equipment in quantities identified. The Materials List may vary from station to station. The Contractor shall furnish, install, and test all miscellaneous material that is required for a complete and functional system.

2.02 SCHEDULE

A. As part of this Contract, the Contractor shall submit a schedule to SCRRRA for review and Approval. This schedule shall include details including developing Plans, procurement of equipment, site preparation, installation, and testing. The Contractor shall update this schedule every two weeks and shall submit it to SCRRRA for review and Approval. The schedule shall be in bar chart or Gantt chart format and shall also show planned activities for next two weeks.
PART 3 - EXECUTION

A. Upon Authorization, the Contractor shall install all equipment per requirements in this Specifications and Plans and per the Contractor developed Plans. The Contractor shall seamlessly interface the new equipment with the existing equipment to deliver a fully functional system.

B. Removal of the existing equipment as specified in the CIS related contract documents is included in this work.

C. Upon completing the installation, the Contractor shall test all equipment and verify that the equipment functions as intended.

D. All equipment and installations shall meet the Los Angeles region zone 4 earthquake requirements.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Customer Information System (CIS) will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Constructing pads, supports, foundations, conduits, replacement and installation of Speaker Cables, replacement and installation of Ambient Noise Sensor/2 Wire Handset/Microphone Cables, replacement and installation of Audio Cables, replacement and installation of HDMI Cables, replacement and installation of fiber optic cables, and replacement and installation of conduits and wiring for power are considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section.

C. All materials, work and services included in Sections 29 00 20, Standards, Abbreviations and Definitions (CIS); 29 10 60, Power Distribution Testing and Commissioning; and 29 20 60, System Testing and Commissioning will be included in this Section and are considered incidental to work under this Section and will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer.

D. All material, work, and services for Conductors and Cables for communications system is considered incidental to work associated with project item in Section 26 12 00, Conductors and Cables – Low Voltage and no separate measurement and payment will be made to the Contractor for Work of this Section.

F. All material, work, and services for Conduits, Raceways, and Boxes for communications system is considered incidental to work associated with project item in Section 26 13 00, Conduits, Raceways, and Boxes and no separate measurement and payment will be made to the Contractor for Work of this
Section 29 00 00

Summary of
Customer Information System (CIS) Work

4.02 PAYMENT

A. Customer Information System (CIS) furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
PART 1 – GENERAL

1.01 SUMMARY

A. This section defines the standards, abbreviations, and definitions used throughout these CIS specifications.

B. The Contractor shall use the most current versions of standards, codes, regulations at the time of contract award. The Contractor shall comply with all applicable standards, codes, and regulatory requirements even if those standards, codes, and regulations are not specifically identified herein.

1.02 REFERENCES

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<tr>
<td>A-D/D-A</td>
<td>Analog to Digital/Digital to Analog</td>
</tr>
<tr>
<td>ANS</td>
<td>Ambient Noise Sensor</td>
</tr>
<tr>
<td>BNC</td>
<td>Bayonet Neill-Concelman</td>
</tr>
<tr>
<td>BTU</td>
<td>British Thermal Units</td>
</tr>
<tr>
<td>C&amp;S</td>
<td>Communications and Signaling</td>
</tr>
<tr>
<td>CMS</td>
<td>Changeable Message Sign</td>
</tr>
<tr>
<td>CIS</td>
<td>Customer Information System</td>
</tr>
<tr>
<td>CVBS</td>
<td>Composite Video Baseband Signal</td>
</tr>
<tr>
<td>EMP</td>
<td>Emergency Management Panel</td>
</tr>
<tr>
<td>FO</td>
<td>Fiber Optic</td>
</tr>
<tr>
<td>FOPP</td>
<td>Fiber Optic Patch Panel</td>
</tr>
<tr>
<td>GRS</td>
<td>Galvanized Rigid Steel</td>
</tr>
<tr>
<td>Hz</td>
<td>Hertz</td>
</tr>
<tr>
<td>HDMI</td>
<td>High Definition Multimedia Interface</td>
</tr>
<tr>
<td>IC</td>
<td>Interface Converter</td>
</tr>
<tr>
<td>I/O</td>
<td>Input/Output</td>
</tr>
<tr>
<td>LCD</td>
<td>Liquid Crystal Display</td>
</tr>
<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
</tr>
<tr>
<td>MC</td>
<td>Media Converter</td>
</tr>
<tr>
<td>MCI Building</td>
<td>SCRRRA Headquarters in Downtown Los Angeles</td>
</tr>
<tr>
<td>MOC</td>
<td>Metrolink Operations Center</td>
</tr>
<tr>
<td>MPLS</td>
<td>Multi Protocol Label Switching</td>
</tr>
<tr>
<td>NMP</td>
<td>Network Media Player</td>
</tr>
<tr>
<td>NTCIP</td>
<td>National Transportation Communications for ITS Protocol</td>
</tr>
<tr>
<td>PA</td>
<td>Public Address</td>
</tr>
<tr>
<td>PC</td>
<td>Personal Computer</td>
</tr>
<tr>
<td>PIP</td>
<td>Picture-in-Picture</td>
</tr>
</tbody>
</table>
### Standards, Abbreviations, and Definitions for CIS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCRRA</td>
<td>Southern California Regional Rail Authority</td>
</tr>
<tr>
<td>SFP</td>
<td>Small Form Factor Pluggable</td>
</tr>
<tr>
<td>SOW</td>
<td>Statement Of Work</td>
</tr>
<tr>
<td>TCIP</td>
<td>Transit Communications Interface Profile</td>
</tr>
<tr>
<td>TFT</td>
<td>Thin Film Transistor</td>
</tr>
<tr>
<td>THD</td>
<td>Total Harmonic Distortion</td>
</tr>
<tr>
<td>UL</td>
<td>Underwriters Laboratories</td>
</tr>
<tr>
<td>UPS</td>
<td>Uninterruptible Power Supply</td>
</tr>
<tr>
<td>USB</td>
<td>Universal Serial Bus</td>
</tr>
<tr>
<td>V</td>
<td>Volts</td>
</tr>
<tr>
<td>VGA</td>
<td>Video Graphics Array</td>
</tr>
<tr>
<td>VLAN</td>
<td>Virtual Local Area Network</td>
</tr>
</tbody>
</table>

### PART 2 – PRODUCTS

Not applicable to this Section.

### PART 3 - EXECUTION

Not applicable to this Section.

### PART 4 – MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

**END OF SECTION**
PART 1 – GENERAL

1.01 SUMMARY

A. This section identifies the requirements for testing and commissioning the power distribution to all the installed equipment. Power to the following equipment shall be tested for both existing and new stations:

1. Ethernet switch
2. Amplifiers
3. Ambient Noise Sensor (ANS) and priority controller
4. Audio Decoder
5. Interface converters
6. Media converters
7. NMP
8. LCD monitor(s)
9. LED message signs and strobe light
10. Transient voltage suppressor system
11. UPS and UPS batteries

B. Related Specification Section but are not necessarily limited to:

1. Section 26 06 00 – Grounding and Bonding
2. Section 26 12 00 – Conductors and Cables – Low Voltage
3. Section 26 13 00 – Conduits, Raceways, and Boxes
4. Section 29 00 00 - Summary of Work CIS Work
5. Section 29 00 20 - Standards, Abbreviations, and Definitions for CIS

PART 2 – PRODUCTS

Not Applicable to this Section.
PART 3 - EXECUTION

3.01 POWER DISTRIBUTION TESTING

A. The Contractor shall develop a test procedure and shall Submit it for SCRRRA’s review and Approval. SCRRRA may Approve, Conditionally Approve, or Disapprove the procedure and shall provide appropriate comments. If Conditionally Approved, the Contractor shall correct the deficiencies prior to testing at no additional cost to SCRRRA. If Disapproved the Contractor shall correct the deficiencies and resubmit the procedure to SCRRRA for Approval at no additional cost to SCRRRA. The procedure shall include the following as a minimum:

1. Test objective.
2. List of equipment required to setup and conduct the test and calibration dates, calibration due dates. With proof of certifications.
3. Support needed from SCRRRA for site access and access to SCRRRA’s locked communications shelters and cabinets.
5. Provisions for recording test results and test data forms to record test results.

B. The Contractor shall obtain Approval for testing and shall test all enclosures, conduits, raceways, exposed expansion joints, for continuity to the ground. The test results shall be submitted to SCRRRA for review and Approval.

C. The Contractor shall obtain Approval for testing, test, and record ground resistance of all grounded equipment and shall ensure that they are adequately grounded. The test results shall be submitted to SCRRRA for review and Approval.

D. The Contractor shall obtain Approval for testing, test and verify insulation resistance. The test results shall be submitted to SCRRRA for review and Approval.

E. The Contractor shall give at least two weeks notice to SCRRRA prior to the testing date. SCRRRA at its discretion may witness any tests or may not witness the tests. The test results shall be signed by the person or persons conducting the test, engineering manager, and quality control staff of the Contractor. The Contractor shall submit four (4) copies and an original of the test results to the SCRRRA for review and Approval.

F. If any of the above tests fail and results are Disapproved by SCRRRA, the Contractor, at no additional expense to SCRRRA shall re-test the equipment, assembly, enclosures, conduits, raceways, expansion joints, and any other elements as necessary. The Contractor shall ensure that the cause of test failures is corrected in a reasonable time and that all tests pass.
PART 4 – MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 29 20 20
COMMUNICATIONS SERVICES

PART 1 - SUMMARY

1.01 CUSTOMER INFORMATION SYSTEM

A. This section describes the general requirements for the CIS equipment procurement and installation. The CIS to be installed in stations shall consist of the following major equipment:

1. Ethernet Switch.
2. Public address including speakers, ambient noise sensor, priority controller, amplifier(s), emergency management panel(s), and audio decoder.
3. Media converter(s).
4. LED message signs with strobe lights.
5. LCD Monitor(s) with NMP, enclosure(s) and accessories.
6. Power supplies.
7. Uninterruptible Power Supply (UPS), Batteries, with transient voltage suppression.
8. Miscellaneous equipment such as mounting poles, brackets, and enclosures.
9. Fiber optic patch panels, cables, and connectors.

B. Functional Requirements are described below:

1. Fiber optic cables shall be routed from the Communications Shelter based Ethernet Switch to the message signs via the FOPPs as shown in the contract plans. Fiber strands shall be dropped at each message sign in a drop-and-continue topology as shown in contract documents.

2. The LCD monitors shall be installed as shown in contract plans. The LCD monitors shall be installed at a location convenient for passengers to view train schedules and it may be mounted on a stand-alone post or may be mounted on a structure such as a canopy. The Contractor shall submit the shop plans showing the installation and mounting detail for each LCD Monitor for Engineer’s approval.
3. The Contractor shall procure equipment as indicated in the materials list in the plans and the tables below. Equipment shall include, Ethernet Switches, amplifiers, NMP, media and interface converters, LCD monitor(s), LED message signs, EMP(s), strobe lights, ambient noise sensing controllers, audio decoder, fiber optic patch panels, UPS, transient voltage suppressor, power supplies, and other related equipment as stated in these specifications and shown in the contract plans. The Contractor shall install all the equipment for CIS within the Communications Shelter and station platform locations and interface the equipment per requirements in these specifications and plans.

4. The stations shall interface with the SCRRA’s Network with MPLS Router installed in the station communications shelter/Room.

5. The SCRRA will provide all CIS related software interface between the SCRRA and Amtrak at the MOC. The Contractor shall coordinate with the SCRRA to ensure that proper messages are displayed on the LED message signs, LCD monitors, and PA system for Amtrak and SCRRA trains at each station.

C. Related Specifications include but are not limited to:

1. Section 26 06 00 – Grounding and Bonding
2. Section 26 12 00 – Conductors and Cables – Low Voltage
3. Section 26 13 00 – Conduits, Raceways, and Boxes
   1. Section 29 00 00 – Summary of Work CIS Work.
   2. Section 29 00 20 - Standards, Abbreviations, and Definitions for CIS
   3. Section 29 20 60 - System Testing And Commissioning.

PART 2 - PRODUCTS

2.01 MATERIALS

A. The Contractor shall provide the Equipment/Product or approved equivalent for each listed item in Table 1 - Materials List:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description</th>
<th>Manufacturer</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ethernet Switch</td>
<td>Cisco</td>
<td>SRW2048</td>
</tr>
<tr>
<td>2.</td>
<td>Audio Amplifier</td>
<td>Crown</td>
<td>CTs 4200</td>
</tr>
<tr>
<td>3.</td>
<td>Priority Controller</td>
<td>BSS Audio</td>
<td>BLU-16</td>
</tr>
<tr>
<td>4.</td>
<td>42” Commercial LCD Display</td>
<td>Viewsonic</td>
<td>CD4220</td>
</tr>
<tr>
<td>Item No.</td>
<td>Description</td>
<td>Manufacturer</td>
<td>Model</td>
</tr>
<tr>
<td>---------</td>
<td>--------------------------------------------------</td>
<td>--------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>5.</td>
<td>Network Media Player</td>
<td>Viewsonic</td>
<td>NMP-530, VS11681</td>
</tr>
<tr>
<td>6.</td>
<td>Strobe Light</td>
<td>Federal Signal</td>
<td>131DST</td>
</tr>
<tr>
<td>7.</td>
<td>Audio Decoder</td>
<td>MDOWK</td>
<td>Audio TX STL-IP-1</td>
</tr>
<tr>
<td>8.</td>
<td>Environmental Distribution Center</td>
<td>Corning</td>
<td>EDC-02P-NH</td>
</tr>
<tr>
<td>9.</td>
<td>LED Message Display</td>
<td>-</td>
<td>See Section 3.02</td>
</tr>
<tr>
<td>10.</td>
<td>EMP</td>
<td>AT&amp;T</td>
<td>PI 305</td>
</tr>
<tr>
<td>11.</td>
<td>Rack Mount Connector Housing</td>
<td>Corning</td>
<td>PCH-04U</td>
</tr>
<tr>
<td>12.</td>
<td>Transient Voltage Suppression</td>
<td>Eaton Innovative Technology</td>
<td>PT Series</td>
</tr>
<tr>
<td>13.</td>
<td>UPS</td>
<td>Eaton Innovative Technology</td>
<td>9130</td>
</tr>
<tr>
<td>14.</td>
<td>Closet Connector Housing – Pigtail Modules</td>
<td>Corning</td>
<td>CCH-CP-12-91</td>
</tr>
<tr>
<td>15.</td>
<td>Splice Trays</td>
<td>Corning</td>
<td>M67-048</td>
</tr>
<tr>
<td>16.</td>
<td>Bracket Inside Connector Housing</td>
<td>Corning</td>
<td>PC4-SPLC-12SR</td>
</tr>
<tr>
<td>16.</td>
<td>LCD Enclosure (Including 42” monitor enclosure, insulation, enclosure post, brackets, mounts, T20 2000 BTU Air Conditioner/Heater), Stainless Steel mounting post and brackets</td>
<td>ITS Enclosures</td>
<td>Various, See Section 3.05</td>
</tr>
<tr>
<td>17.</td>
<td>Speakers</td>
<td>University Sound</td>
<td>PA430T</td>
</tr>
<tr>
<td>18.</td>
<td>Modular Media Converter</td>
<td>Opterna</td>
<td>12000C</td>
</tr>
<tr>
<td>19.</td>
<td>Speaker Cable</td>
<td>Belden</td>
<td>1311 A</td>
</tr>
<tr>
<td>20.</td>
<td>Ambient Noise Sensor/2 Wire Handset/Microphone Cable</td>
<td>Belden</td>
<td>1776</td>
</tr>
<tr>
<td>21.</td>
<td>Audio Cable</td>
<td>Belden</td>
<td>6300FE</td>
</tr>
<tr>
<td>22.</td>
<td>HDMI Cable</td>
<td>Belden</td>
<td>HD2003</td>
</tr>
</tbody>
</table>

B. The materials list only describes the major equipment. The Contractor shall procure brackets for mounting LED message signs, brackets and posts for mounting LCD monitor, wires, cables, connectors and heat shrink fusion splice protector. If the Contractor chooses to propose equipment other than that identified above, the Contractor shall submit all cut sheets, data sheets, reports, and other necessary documentation to SCRRA for review and seek Approval for utilizing the equipment. Based on the review of documents and discussion with the Contractor, SCRRA may or may not approve such request. SCRRA shall have the right to request Approved equivalent of any and all the equipment prior to ordering the equipment.

C. Cables and Connectors:
1. Category 6 cable and patch cords procured by the Contractor, shall have attenuation of less than or equivalent to 23.6 dB at 100 MHz; and 39.1 dB at 250 MHz.
   a. The conductors shall be 24 AWG gauge.
   b. Impedance shall be 100 ohms, + or – 15 ohms at 100 MHz, 100 ohms, + or – 22 ohms at 100-550 MHz.
   c. Maximum mutual capacitance shall be 56 pF/m.
   d. Near End Cross Talk (NEXT) shall be 45 dB at 100 MHz and 39 dB at 250 MHz.
   e. The cable shall comply with requirements of TIA/EIA 568 for Category 6 cables.
   f. Maximum length of the Cat 6 cable shall be 328 feet including all patch and cross-connect cables.
   g. The Connector used shall be RJ 45.

2. The fiber optic cable and fiber optic patch cords shall be multimode 850 nm, supplied by Corning Cable Systems or Approved equivalent and shall meet or exceed the following minimum Specifications:
   a. Each optical fiber shall be sufficiently free of surface imperfections and inclusions to meet the optical and mechanical requirements of the Work identified herein and environmental conditions encountered in Greater Los Angeles region.
   b. Each optical fiber shall consist of a germania-doped silica core surrounded by a concentric glass cladding. The fiber shall be matched clad design.
   c. Each optical fiber shall be proof tested by the manufacturer at a minimum of 100 KPSI.
      1) Attenuation shall be ≤ 3.4 dB/Km.
      2) Point discontinuity shall be ≤ 0.2 dB.
      3) Effective modal bandwidth shall be ≥ 220 MHz-Km.
      4) Cladding diameter shall be 125.0 + or – 2.0 μm with a core diameter of 62.5 + or – 3.0 μm, and the coating diameter of 245 + or – 5 μm.
d. All multimode fiber optic patch cords and connectors shall be colored orange. SC type connectors shall be used for all fiber optic cable connections. In addition, the Contractor shall also procure all miscellaneous equipment needed to ensure that the system is complete and functions as intended.

3. The Contractor shall get an approval from the Engineer if the conductor size of the speakers/microphone/2 wire handset/audio cable (s) needs to be changed due to distance, current, or voltage limitation. The Audio Connector shall be selected such that they are compatible to the Equipment port they are connected to.

PART 3 - EXECUTION

3.01 PUBLIC ADDRESS (PA) SYSTEM

A. This section describes the detailed requirements for the PA System. The speakers’ cable continuity test shall be based on audio announcement tests from the MOC, MCI Building, and the EMP conducted by the Contractor with AUTHORITY and SCRRAs oversight. The following describe the requirements for PA part of the CIS.

1. The PA system shall include two amplifiers and shall be connected as shown in contract plans. An alternative design may be proposed for Engineer’s approval by the contractor where one amplifier shall function as primary and the second shall be hot standby. The stations shall also include audio decoder, priority controller, interface and media converters, power supplies, connectors, wires, and cables.

2. The Contractor shall seamlessly interface the PA system equipment with power in Communications Shelter/Room and speakers to deliver a fully functional PA system. The PA system shall be capable of providing routine and special announcements at specific stations, groups of stations, or systemwide. All announcements shall be generated either live locally from the EMP, MCI building, the MOC, or via pre-recorded messages stored, activated, and transmitted from the MOC.

3. The Communications Shelter/Room shall house the PA system as specified in Contract Documents.

4. An acoustical modeling and test measurements shall be performed to verify conformance of the PA system design as indicated in ANSI S3.2 for intelligibility of speech and voice announcement requirements for a minimum Articulation Index of 0.80.

5. The Modeling shall include recommended locations and number of additional speakers necessary for a PA system to achieve an average of 80 dBA plus or minus 3 Db at 5 feet above floor levels in accordance with ANSI S1.8 and S1.13. The background ambient noise level of 60 dBA shall be used to calculate the nominal sound pressure level in accordance with S1.13.
6. The Contractor shall interface the ambient noise sensor at each platform with the priority controller. The contractor shall terminate the existing ambient noise sensor and handset to the priority controller in the communication shelter/room as shown on the contract plans. The amplifier and associated electronics shall adjust the PA output based on the ambient noise levels. If the ambient noise levels exceed acceptable levels the System shall delay non-EMP originated announcements until the ambient noise subsides to acceptable levels.

7. As a minimum, the amplifier shall meet the following requirements:
   a. All active components shall be solid state devices.
   b. Overall frequency response shall be 20 Hz to 20 KHz at 1 Watt.
   c. The THD shall not be greater than 0.1% at maximum average power.
   d. Signal to noise ratio below the rated power shall be 100 dB unweighted.
   e. Amplifier shall be equipped with protection from shorted, open and mismatched loads, overheating, high frequency overloads, under/over voltage protection, and internal faults.
   f. The amplifier shall detect and isolate channel specific faults. Fault or failure in one channel shall not affect other channels.
   g. Ability to select either 4 Ohms or 8 Ohms per channel, dual 70V.
   h. Indicators on the front panel for ON/OFF, failures/faults, and AC power available.
   i. Durable industrial or transit use with forced air ventilation from the front to the side panels.
   j. Standard 19 inch EIA rack mounting ability weighing less than 30 LBS.

8. Half the speakers on each platform shall be part of a loop known as a zone 1 and remainder of the speakers shall be on the second loop also known as zone 2 as shown in contract plans. Each platform shall be equipped with two (2) zones. In case of failure in one loop, the other loop shall function without interruption. Dual platform stations shall be equipped with four zones. Triple platform stations shall be equipped with six zones. These shall be connected to separate outputs from the amplifier(s) and each alternate speaker shall be connected to one loop. Failure in one loop shall not cause failure in the other loops.
9. All equipment shall be able to withstand the weather conditions normally encountered in San Bernardino region. All enclosures shall be water resistant and shall comply with NEMA 4X requirements. All equipment installed within the Communications Shelter/Room shall be mounted on standard equipment racks with standard EIA mounting positions. All equipment and installations shall meet the San Bernardino region zone 4 and other earthquake requirements.

10. The PA part of the CIS System shall be equipped with priority control. The System shall be able to detect the input source and shall be able to assign priority to each input as shown below.

<table>
<thead>
<tr>
<th>Priority Level</th>
<th>Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>From the EMP</td>
</tr>
<tr>
<td>Second</td>
<td>From Microphone in AUTHORITY Security Room</td>
</tr>
<tr>
<td>Third</td>
<td>From the MOC</td>
</tr>
<tr>
<td>Fourth</td>
<td>Pre-recorded announcements</td>
</tr>
</tbody>
</table>

11. If a higher level priority message is in progress, and a lower priority level message attempts to make an announcement, the system shall permit the high level priority message and shall hold the lower level priority message. After the completion of the higher level priority message the lower level priority message shall be permitted to play automatically. If a lower level priority message is in progress and a message with higher level priority is transmitted, the lower level priority message shall be interrupted and the message with the higher priority shall be broadcasted.

3.02 LIGHT EMITTING DIODE (LED) MESSAGE SIGNS

A. The Contractor shall procure and install LED message signs and associated equipment as part of the CIS per requirements in these specifications and Contract plans. The equipment shall include signs and associated electronics, enclosures, strobe lights, patch panels, wires, cables, connectors, media/interface converters, and interfaces with the Communications Shelter/Room. The following describe requirements for the LED message signs.

1. The LED message signs shall be able to display messages transmitted from the MCI building (SCRRA headquarters) in downtown Los Angeles and the MOC. All signs shall be single-faced.

B. The Contractor shall install the LED message signs at their original locations and shall interface them as shown in the contract plans, per LED message sign manufacturer’s installation guidelines, and per requirements in the specifications. The LED message signs shall be protected by a 120 VAC, 1P, 20 A circuit breaker.
1. The LED message signs shall be individually IP addressable with fiber optic interface as shown in the plans and required by Specifications.

2. The LED message signs including the enclosure shall have following characteristics:
   a. Not more than seventeen (17) IN high x fifty five (55) inch wide x eleven (11) inch deep.
   b. The character height shall comply with all ADA requirements.
   c. All LEDs shall be amber colored.
   d. Character height shall not be less than three (3) inch and shall have the ability to display a minimum of four (4) font styles.
   e. Display width shall not be less than forty (40) inch.
   f. The LED message signs shall be capable of displaying at least two rows of three (3) inch characters each simultaneously, or one row of at least four (4) inch characters, or one row of at least six (6) inch characters.
   g. The enclosures shall be either powder coated black or dark brown and shall be compliant with NEMA 4X requirements.

3. The LED message signs shall be equipped with automatic brightness control. Based on ambient light level the LED brightness shall automatically adjust. All LEDs shall have the same light output intensity. The LEDs shall not fluctuate during variable light conditions. A tinted lens shall reduce the glare and improve readability under bright sunlight conditions.

4. The signs and their installation shall comply with Section 49 CFR parts 27, 37, and 38; California Building Code, Section 414, and shall comply with all local jurisdictions.

5. The Contractor shall ensure that all the signs shall be able to accept the data in XML format and display the messages correctly as intended.

6. The Contractor shall coordinate closely with SCRRAs's staff for proper message format, letter heights, fonts, message display methods and other characteristics.

7. Each LED message sign shall have capability to store at least sixty (60) messages. The signs shall be able to flash, scroll, and roll messages. Service life of the LEDs shall not be less than 100,000 hours.
8. The viewing angles shall be minimum seventy (70) degrees horizontally and thirty (30) degrees vertically. Upon installation of the LED message signs the Contractor shall demonstrate that these angles are met. The LED message sign shall have a minimum six (6) dimming levels. The Contractor shall provide a Shop Drawing for LED Message Sign mounting detail for Engineer’s approval.

9. The LED message sign lens shall be at least 1/8 IN shatterproof, UV coated polycarbonate with structural aluminum and the enclosures shall be vandal resistant and tamper-proof.

10. The message sign with the enclosure shall be mounted with the mounting bracket as shown in the contract plans. Mounting bracket shall be powder coated to match the sign.

11. The total weight of the LED message sign including the media/interface converters, enclosures, mounting hardware, sunshield, strobe, and all associated assembly and equipment shall not be more than 70 LBS.

12. LED message signs shall be hinged at the top of the enclosure to provide front access for easy maintenance. It shall not be necessary to remove the sign from the mounted position for either resetting the processor within the sign and to maintain it.

13. LED message signs shall be equipped with high security tamper proof fasteners and screws.

14. The contractor shall provide mounting hardware and sunshield of appropriate size as shown on the plans. Mounting hardware shall include sign mounting bracket, sunshield supports, mounting plates, bolts and all necessary hardware for securing the sign.

15. The signs shall be mounted at a height of twelve (12) FT nominal from the top of the platform to the bottom of the sign enclosure. Deviations from this mounting height, based on site specific conditions shall be requested in writing by the Contractor. The mounting height specified herein shall remain unless a deviation is approved by SCRRA. The signs shall be clearly visible and shall not be obstructed by structures or other objects on the stations.

16. All installations shall meet all the requirements of Americans with Disabilities Act (ADA).

3.03 STROBE LIGHTS

A. The Contractor shall procure and supply strobe lights with double flash strobe, with a flash rate of 80 flashes/minute. The strobe shall be powered by 120 VAC, 60 Hz. and shall be equipped with clear dome.
1. The strobes shall be less than nine (9) inch high and less than six (6) inch in diameter. The strobes shall contain their own strobe power supply in the base of the light.

2. The strobe flash tube is mounted in an eight (8) pin octal socket base. The tube shall be able to withstand the weather typically encountered in Los Angeles region.

3. Strobes shall be UL and listed and CSA certified.

4. The Strobe light shall have a minimum life of at least 10,000 hours. The total weight shall not exceed 3.4 lbs.

5. The Strobe lights shall be interfaced with the LED sign enclosure and shall function as one single unit. All interfaces to the Strobe light shall be included within the LED message sign enclosure.

   a. The Contract Documents provide the general location of the strobe light on top of the LED message sign. The Contractor may have to mount the strobe light either on the center or on the side based on the visibility. The Contractor shall submit the strobe light mounting details for Engineer’s approval making sure that the strobe lights are clearly visible to the passengers on the platform.

   b. The Strobe lights shall be activated upon transmission of emergency messages to the LED message signs. Upon receiving an emergency message, the Strobe light shall begin to flash.

3.04 LIQUID CRYSTAL DISPLAY (LCD) MONITOR

A. The Contractor shall install LCD monitors at each station, near the TVMs, on its own stand alone stainless steel post or on steel columns inside canopy. The Contractor shall develop and submit the installation and mounting detail for each LCD monitor for Engineer’s approval.

B. One 1 IN conduit shall be installed as shown in the plans from the nearest communications pullbox to the LCD to transmit signals.

C. The Contractor shall follow the power conduit requirements for the LCD Monitors as indicated in these contract documents.

D. The LCD monitor shall be enclosed in a NEMA 4X compliant enclosure and shall have the screen visible through a, vandal-resistant, laminated glass. The enclosure shall be able to house a MC and a NMP which shall be interfaced with the LCD monitor with HDMI cable.

E. The LCD monitor shall interface with the MPLS switch via 850 nm multimode fiber optic cable as shown in the plans.

F. The LCD monitor, the NMP, MC, and the enclosure shall comply with the following requirements:
1. The LCD shall be Viewsonic, forty-two (42) inch commercial display, model CD4220 or approved equivalent. TFT active matrix display with minimum display area of 36.6 inch horizontal x 20.6 inch vertical. Minimum resolution shall be 1366 x 768 pixels. The contrast ratio shall be 1500:1 typical.

2. The monitor shall support all viewing angles from 178 degrees horizontal to 178 degrees vertical. The light source shall have typical life of 50,000 HRS. The aspect ratio shall be 16:9 and the panel shall be coated with anti-glare coating.

3. The monitor shall accept HDMI, S-video, component, composite, and RCA type video inputs. The video outputs shall permit images to be displayed in VGA, BNC, and RCA formats.

4. The monitor shall be equipped with RS-232 input and output.

5. The monitor shall be able to display high-definition video in 480i, 480p, 720p, and 1080i formats.

6. The monitor shall be equipped with two (2) 10-Watt speakers, an analog 15-pin mini D-sub (VGA), digital HDMI.

7. The monitor shall function on standard 120 VAC, 60 Hz and shall consume less than 250 Watts, typical.

8. The monitor shall be equipped with the following controls: Power (On/Off), mute, input, volume control, channel up/down, brightness, contrast, sharpness, black level, noise reduction, and tint, color, color temperature, and color control. The monitor shall have PIP capability.

9. The monitor shall operate in environments typically encountered in Los Angeles region. The dimensions shall not be more than 40.2 x 24.1 x 5.0 inch. The gross weight shall not exceed 76.5 lbs. Monitor shall comply with UL, FCC, UCIEE, ICES 003.

10. The LCD monitor shall be mounted at a height of 8 feet, to the bottom of LCD enclosure with 20 degrees tilt to the monitor for clear visibility. The mounting shall avoid glare and reflected light. The final mounting and angle may differ for each station.

3.05 LCD MONITOR ENCLOSURE

A. As part of this Contract, the Contractor shall supply an enclosure for the LCD monitor from ITS Enclosures which includes 42 inch universal view station, arm support assembly, 4 inch drop pipe, T20 outdoor 2000 BTU AC unit, T20 suspension assembly and interior support bracket:

1. 42 inch View Station:
a. Model Numbers: VS-U-42-NC-BL or VS-U-42-NC-SLV or approved equivalent.

2. Arm Support Assembly:
   a. Model number VS-X7004-00 or approved equivalent.

3. 4 inch Drop Pipe:
   a. Part number VS-X7002-7-4 or approved equivalent.

4. T20 outdoor 2000 BTU air conditioner and heater.
   a. Model number MC-T20-0216-G150 or Approved equivalent.

5. Suspension Assembly:
   a. Part number VS-X7003-1 or approved equivalent.

6. Bracket:
   a. Part numbers VS-PEE-201-0171-SLC, VS-T20-WALLMOUNT-SS or Approved equivalents.

7. Tilt assembly and stainless steel post assembly:
   a. Part number VS-POST-SS or Approved equivalent.

8. This list includes only major items. The Contractor shall include all brackets, assemblies, and additional equipment required to complete the installation as required either for a post or wall mount installation.

9. At Contractor shall submit the shop plans for Engineer’s approval showing the installation type at each location based on the best visibility and available means and methods for installation.

10. The enclosure shall also be able to house the NMP and the media converter with sufficient room for power strip.

11. The enclosure shall be aluminum body, with painted finish and shall be water resistant. It shall be equipped with anti-reflective tamper-resistant, laminated glass window with anti-reflective coating on the glass.

12. The enclosure shall be industrial quality for outdoor LCD installations. It shall be equipped with locks, 3 or 4 tubular keyed compression latches located in the rear of the enclosure. The struts, latches, or other mechanism associated with the enclosure shall not interfere with opening and closing of the enclosure.

13. The enclosure shall be equipped with a 6-outlet 115VAC, 15 amp power strip. The front cover shall be easily opened for maintenance and replacement using gas struts.
14. The enclosure shall also be equipped with slip hinges for cover removal. The enclosure shall be equipped with a built-in air conditioner and heater of sufficient capacity to maintain the LCD monitor, up to two NMPs, and up to two media converters.

15. The enclosure shall meet all the temperature requirements per SCRRA’s Design Criteria.

B. The display size of the enclosure shall allow space for air circulation near the front window.

C. The enclosure shall be able to accommodate monitors of dimensions 49.5 x 27 x 5.5 inch.

D. The enclosure shall not weigh more than 210 lbs. including the air conditioner and heater unit.

E. The enclosure shall be installed to face either North or South direction whenever possible to avoid direct sunlight.

3.06 NETWORK MEDIA PLAYER (NMP)

A. This NMP shall be installed within the LCD monitor enclosure. The NMP shall be interfaced with the monitor as shown in the Plans. The NMP shall meet or exceed the requirements identified below.

1. The NMP shall be able to interface with a PC with any Windows or Linux operating system capable of running a web server with a 100 Base-Tx interface. The NMP shall be network ready and shall include integrated web browser with Flash plug-in, standalone Flash player, HD player.

2. The NMP shall use IP and shall comply with MPEG4 formats and Macromedia Flash platform. NMP shall also support the multicast and unicast digital broadcast applications. The NMP shall be equipped with multiple video outputs and shall be controllable remotely from a network or internet connections.

3. The NMP shall be equipped with at least one USB port, at least one HDMI interface, S-Video/YPbPr interface, CVBS interface, audio interfaces, at least one RS232 port, at least one Ethernet 10/100 port, and shall function on 5VDC power.

4. The NMP shall manageable and controllable from any commercially available browser via a network. The user shall be able to manage operating mode, brightness, contrast, audio volume, and security remotely over the network.

3.07 AMBIENT NOISE SENSOR (ANS) AND PRIORITY CONTROLLER

A. The ANS and priority controller shall be interfaced with the EMP as shown in the Contract Plans.
B. The ANS and priority controller shall be a stand-alone unit with one rack space. It shall be capable of providing full functional inputs and outputs with at least 16 analog inputs and outputs configurable by input cards and output cards, without the need of on-line dedicated computer.

C. Combination of microphone and line inputs shall be provided together with channel selectable 48 volt phantom power per input. The unit shall be equipped with a tamper-resistant front panel with no user-adjustable controls. The front panel LEDs shall provide the monitoring of communications presence, clip and network status.

D. Analog to digital conversion shall be by 24-bit A-D/D-A converters to provide maximum operating headroom and performance. The ANS and priority controller shall be equipped to be interfaced with Ethernet and CobraNet. Interface shall be over Category 6 cable with RJ-45 connector.

E. The ANS and priority controller shall be equipped to be interfaced with a commercially available user supplied personal computer (not part of this Contract) for system configuration. After configuration the computer may be disconnected without loss of the system configuration. The user shall be able to recall the system configuration at any time and shall be able to change them via vendor supplied software.

F. An RS-232 port shall be provided to allow control of the ANS and priority controller. The ANS and priority controller shall be supplied with software to aid in system management. The software shall provide methods of event logging and diagnostics. The event log shall include failures, warnings and information notices. Each event shall be stamped with time and date.

3.08 MEDIA AND INTERFACE CONVERTERS

A. The media converter shall support 10BASE-T, 100BASE-TX, and 1000BASE-TX for distances up to 2 Km and shall support SC type connectors. The Contractor shall get Engineer’s approval if other Connector types such as LC, ST, or MTRJ are proposed due to compatibility issue.

B. The media converter shall have the capability of hot-swappable converter cards. It shall support half and full duplex transparently.

3.09 UNINTERRUPTIBLE POWER SUPPLY

A. The Contractor shall supply a UPS with surge protection and internal battery. Upon power failure, the battery shall support the LED signs and CIS Equipment in Communications Shelter/Room. If the internal battery is unable to support the required time, then the Contractor shall supply external batteries to support the equipment.
B. The battery shall support one third of the LED message signs on the station for one (1) HR. Alternatively, the battery shall be able to support all the LED message signs on the station for at least 20 minutes with all signs functioning. To meet UPS and Battery requirements, the Contractor may choose to select a UPS and transient voltage suppression system of a different make and model than those identified in these Specifications. If the Contractor chooses to identify and install a different UPS and transient voltage suppression system, the Contractor submit all data sheets, cut sheets and other information for Engineer’s review and Approval.

1. The surge protector shall be manufactured by Eaton Innovative Technologies or Approved equivalent. It shall be equipped with surge path technology for high fault current capacity, and shall be low impedance, high frequency design.
2. The unit shall be adequately encapsulated and shall provide a high dielectric and shall protect the unit from adverse environmental conditions. The enclosure shall be rugged NEMA 4 compliant minimum.
3. The surge protector shall be equipped with Metal Oxide Varistors, dry Form C contacts for remote status monitoring, LEDs to monitor each phase.
4. The unit shall comply with ANSI IEEE Cat A1, C3, B3/C1, and UL1449 (3rd Edition) requirements.
5. The UPS shall be rated for the connected load plus a minimum of 25 percent spare capacity but not less than 2000 VA. It shall function on 120 VAC, 60 Hz and shall be rack mountable. It shall be equipped with two individually controlled load segments, communications bay, and at least one USB port. It shall include hot swappable batteries.
6. The UPS shall be equipped with graphical LCD with backlight and status indicating LEDs. It shall be capable of self-test and indicate failures on the LEDs.
7. It shall comply with UL, CUL, VCCI, FCC Class A, B requirements.

3.10 ETHERNET SWITCH

A. The Ethernet switch shall be equipped with 48, RJ-45 connectors for 10Base-T, 100Base-Tx, and 1000Base-T with four (4) shared Small Form-Factor Pluggable (SFP) slots.

B. The Contractor shall use UTP Category 6 cable for interfaces. The switching capacity shall be 96 Gbps, nonblocking and shall have at least 256 Virtual Local Area Networks (VLANs).

C. The Ethernet switch shall be equipped with Built-in web user interface for easy browser-based configuration.
D. The Ethernet switch shall support port based, 802.1p VLAN priority based, Internet Protocol (IP) to ToS/DSCP based, and IPv6 traffic-class-based class of services.

E. The Ethernet switch shall comply with all applicable Ethernet standards. It shall function in the environment encountered in Los Angeles region.

### 3.11 SPEAKERS

A. Speakers frequency response shall be 400 to 6,500 Hz, + or – 5 dB.

B. Power handling capacity shall be 30 watts and impedance shall be 8 ohms minimum.

C. Speakers shall be at least one (1) feet above the top of the LED message signs and shall be installed as specified and as shown in contract documents.

### 3.12 EMERGENCY MANAGEMENT PANEL (EMP)

A. The EMP contains ambient noise sensor and telephone set. The priority controller shall interface with the ambient noise sensor and the telephone set within the Emergency Management Panel (EMP). The Contractor shall submit the shop plans showing the installation detail for a typical EMP for Engineer’s approval.

B. The PA system shall be able to adjust the speaker output level based on the noise level sensed by the Ambient Noise Sensor located in the EMP.

C. The telephone set inside the EMP shall be interfaced such that the intelligible paging can be done from the telephone set to the platform speakers.

### 3.13 AUDIO DECODER

A. The Audio Decoder also known as Voice Gateway shall provide live audio over the IP network. The audio decoder shall convert live messages on IP network to interface with the analog speakers.

B. The Audio Decoder shall provide one (1) 10/100BaseT network port and one (1) analog audio channel.

### 3.14 TRANSIENT VOLTAGE SUPPRESSOR

A. The voltage suppressor shall be able to perform the intended function in the environment typically encountered in Los Angeles Area.

B. The suppressor shall have:
   1. Nominal discharge current of 20Ka.
   2. Dry form C contacts for remote monitoring.
   3. LED monitoring of each phase.
4. Monitoring of suppressor functions.
   a. Audible and visual reporting of status.
   b. Phase loss.
   c. Transients.

C. The suppressor shall comply with applicable UL, ANSI, NEMA, and IEEE requirements.

3.15 **FOPP (RACK MOUNT)**

A. The Contractor shall provide a fully functional rack mounted fiber optic patch panel (FOPP) inside the Communications Shelter/Room including Connector housing, brackets, connectors, and splice tray as specified and as shown in these Contract Documents.

B. The contractor shall provide appropriate number of brackets, connector panels and Splice trays as specified and as shown in these Contract Documents.

3.16 **FOPP**

A. The Contractor shall provide a fully functional fiber optic patch panel (FOPP) which comes in form of an environmental distribution center and shall be capable of mounted on the following:

1. Light Pole.
2. Wall.
3. Inside a Cabinet.

B. The fiber optic patch panel (FOPP) shall include environmental distribution center, brackets, connectors, and splice tray as specified and as shown in these Contract Documents.

C. The Contractor shall provide appropriate number of connector panels and Splice trays as specified and as shown in these Contract Documents.

3.17 **GENERAL INSTALLATION**

A. Adequate space shall be provided for termination of cables and in the area surrounding racks.

B. All equipment shall be installed on standard 19 inch racks unless specified otherwise.

C. Passive equipment such as patch panels shall be located on the top of the equipment rack.

D. Active equipment such as routers shall be located at the lower section.
E. Equipment rack space shall be managed and the installation shall be neat and clean.

F. Patch cables shall be arranged in a manner that will cause minimal disruption for maintenance and modifications. All bends in the fiber patch cables, audio patch cables, and CAT 6 patch cables shall abide by the manufacture specified minimum bending radius.

G. All copper cables shall use shielding, isolating, balancing, and grounding techniques in compliance with SCRRRA’s Design Criteria and Signaling and Communications Standards to minimize EMI.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Ethernet Switches, Audio Amplifiers, Priority Controllers, 42” Commercial LCD Display, Network Media Player, Strobe Lights, Audio Decoder, Environmental Distribution Center, LED Message Display, EMP, Rack Mount Connector Housing, Transient Voltage Suppression, UPS, Closet Connector Housing-Pigtail Modules, Splice Trays, Bracket Inside Connector Housing, LCD Enclosure, Speakers, and Modular Media Convertor, will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Replacement of the LED message signs, strobe lights and PA equipment are considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section.

4.02 PAYMENT

A. Ethernet Switches, Audio Amplifiers, Priority Controllers, 42” Commercial LCD Display, Network Media Player, Strobe Lights, Audio Decoder, Environmental Distribution Center, LED Message Display, EMP, Rack Mount Connector Housing, Transient Voltage Suppression, UPS, Closet Connector Housing-Pigtail Modules, Splice Trays, Bracket Inside Connector Housing, LCD Enclosure, Speakers, and Modular Media Convertor furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.
B. Work of this section shall include furnishing all acceptance testing, transportation, storage, assembly, delivery and incidentals as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 29 20 60
SYSTEM TESTING AND COMMISSIONING

PART 1 – GENERAL

1.01 SUMMARY

A. The work specified in this section includes testing and commissioning the CIS. The Contractor shall provide staff and all necessary equipment for testing, commissioning, and delivering a fully functional CIS.

B. Related Specifications include but are not necessarily limited to:
   1. Section 26 06 00 – Grounding and Bonding
   2. 29 00 00 – Summary of CIS Work
   3. Section 29 20 20 - Communications Services

PART 2 – PRODUCTS

Not Applicable to this Section.

PART 3 - EXECUTION

A. SCRRRA may choose to witness any or all the tests. The Contractor shall furnish a written notice at least two (2) weeks in advance to SCRRRA before the testing is scheduled to begin. SCRRRA at its discretion may witness some, all, or none of the testing.

B. The Contractor shall develop a test procedure and shall submit it for SCRRRA’s review and Approval. The procedure shall include the following as a minimum:
   1. Test objective.
   2. List of equipment required to setup and conduct the test including calibration dates and calibration due dates.
   3. Equipment and site access support needed from SCRRRA.
   5. Provisions for recording test results and test data form to record test results.
   6. Provisions for recording the manufacturer, model number, part number and serial number for each equipment installed in each station area.
C. The test results shall be signed by the person(s) conducting the test, engineering manager, and quality control staff of the Contractor. The Contractor shall submit four (4) copies and one (1) original of the test results for SCRRA’s review and Approval. Upon review the SCRRA may Approve, Conditionally Approve, or Disapprove the test results. If Conditionally Approved or Disapproved, the Contractor shall remove all deficiencies including but not limited to conducting repairs, retesting, reinstalling, and rewiring at no additional costs to SCRRA within a reasonable time. The Contractor shall ensure that after the deficiencies are removed and corrective actions are taken AND the test(s) is/are repeated and that they/it pass/passes.

D. As part of the testing process, the Contractor shall test the PA function, the LED message sign function, LCD train arrival/departure function, and finally the integrated CIS function.

1. After the equipment is installed in its entirety, the Contractor shall schedule and conduct the PA function test. The testing shall include broadcasting audio messages from MOC, EMP, and stored or canned messages. The test shall verify the message priority and broadcast of audio from all speakers on the platform.

2. The LED message sign function test shall include transmission of messages from the MOC and verification that the signs display correct messages. The test shall also verify that the strobe lights are activated upon transmission of emergency messages.

3. The Contractor shall confirm that the LCD monitor displays web pages correctly.

4. The Contractor shall ensure and confirm that all installations meet SCRRA’s safety and security requirements.

E. As a result of failure during the test, or if the test does not complete successfully, the Contractor shall take corrective action and shall retest at no additional cost to SCRRA. The Contractor shall take all necessary steps to successfully complete the tests and provide a fully functional CIS as specified herein.

D. All test results, equipment list, and documents become the property of SCRRA.

PART 4 – MEASUREMENT AND PAYMENT

A. Work of this Section is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.
SECTION 31 11 00
SITE CLEARING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Site clearing and grubbing of trees, stumps, undergrowth, brush, trash, grass, weeds, roots, rubbish, refuse, or other debris, modifying irrigation systems, stripping of topsoil and protecting trees within the limits of excavation, embankment, borrow, and other areas as shown on the Contract Plans or required to perform the Work of this Contract.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 01 74 19 – Construction Waste Management and Disposal.
   4. Section 32 90 00 – Soil Erosion, Sediment Control, Topsoiling and Seeding.

1.02 SUBMITTALS

A. General:
   1. Submittals shall be made in accordance with Division 01 requirements.

B. Site Clearing Plan:
   1. A site clearing plan must be prepared by the Contractor and submitted to the Engineer for acceptance prior to commencing work. The site clearing plan shall include:
      a. Location and limits of clearing and grubbing.
      b. Methods for protection of areas of vegetation designated as "no construction zones" and trees noted in plans to be saved.
      c. Methods to be employed and equipment to be used.
      d. Safety measures including signs, barriers, temporary walkways and hand railing.
      e. Haul routes and disposal sites.
f. Permits for transport of materials off the worksite where applicable and other permits as required by local agencies, project environmental documents and the project Plans.

g. Schedule of site clearing activities including anticipated railroad flagging needs.

C. Permits, Notices, Certifications and Authorizations:

1. The following permits, notices, certifications and authorizations shall be obtained with copies submitted by the Contractor to SCRRRA:

   a. Delivery manifests for disposed materials in accordance with site clearing plan and permit conditions in accordance with Division 01 requirements.

   b. Private property owner’s release for material removed and deposited on private property in accordance with Division 01 requirements.

      i. Releases shall absolve SCRRRA and its member agencies from any responsibility in connection with the disposal of materials on private property.

      ii. Releases shall be signed by the owner(s) of the property on which the material will be deposited.

      iii. Two copies of the releases must be submitted to the Engineer for approval not more than 15 days before the start of material being deposited on private property.

   c. Disposal Certification for materials removed from Job Site indicating they have been disposed of in accordance with applicable laws and regulations in accordance with Division 01 requirements.

1.03 ENVIRONMENTAL CONDITIONS

A. On site burning or burial of site clearing materials will not be allowed.

B. The Contractor must take possession of material and debris collected from site clearing procedures and be responsible for disposing of them in accordance with these Specifications, any project permits, and applicable laws and regulations in accordance with Division 01 requirements.

C. Contractor shall provide noise abatement in accordance with Division 01 requirements.

D. Site cleanliness, sweeping and dust control shall be in accordance with Division 01 requirements.
PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SECTION)

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect existing trees, other vegetation, and existing site improvements on SCRRA or adjacent property that are to remain.
   1. Do not smother trees by stockpiling construction materials or excavated materials within drip line.
   2. Avoid foot or vehicular traffic or parking of vehicles within drip line of trees or shrubs.
   3. Provide barricades, coverings, temporary fencing, or other types of temporary protection as required by the Project environmental documents or the Engineer in accordance with the Plans and these Specifications.

B. Repair or replace trees, vegetation, and existing site improvements including modifying irrigation systems that are to remain that are damaged by construction operations.
   1. Repair of damaged trees and shrubs to be performed by a certified arborist or tree surgeon.
   4. Remove trees that are damaged to the extent that a certified arborist or tree surgeon determines cannot be repaired and restored to full-growth status.
      a. Replace with new trees of minimum 4 inches caliper.
   5. Damaged vegetation shall be replaced in-kind as approved by the Engineer.
   6. Existing site improvements will be repaired or replaced as approved by the Engineer.
   7. Irrigation systems shall be modified as shown in the Plans.

C. SCRRA will obtain authority for removal and alteration work, as required by the Plans, on adjoining property prior to Contractor starting work.

3.02 SITE CLEARING

A. Topsoil, fertile, friable soil of a loamy character with organic matter normal to the area, Removal:
   1. Strip topsoil to depths encountered.
      a. Remove heavy growths of grass before stripping.
b. Stop topsoil stripping sufficient distance from such trees to prevent damage to main root system.

c. Separate from underlying subsoil or objectionable material.

2. Stockpile topsoil where directed by Engineer.

   a. Construct stockpiles to freely drain surface water.

   b. Provide temporary cover or seeding of stockpiles to prevent erosion in accordance with SCRRA Standard Specification 32 90 00.

3. Do not strip topsoil in wooded areas where no change in grade occurs.

4. Topsoil from borrow sources shall be free of subsoil, objects over 2 inches dia., weeds and roots.

5. Clearing: Clear from within limits of construction all trees except those marked to remain.

   a. Include shrubs, brush, downed timber, rotten wood, heavy growth of grass and weeds, vines, rubbish, structures and debris.

   b. Rubbish shall be removed from cleared areas and disposed of in accordance with project environmental documents and federal, state and local laws in accordance with Division 01 requirements.

   c. Clearing shall be level with the ground surface so that no obstruction will interfere with close machine or hand mowing of cleared areas.

   d. Cleared areas shall be left smooth and free of obstructions or depressions that will impound water.

B. Removed materials shall become the property of the Contractor and shall be disposed of outside the public right of way in conformance with the provisions in Section 01 74 19 - Construction Waste Management and Disposal and reference Section 300-1.3 “Removal and Disposal of Materials” of the Standard Specifications for Public Works Construction 2009. Within the limits of clearing, all stumps, roots, root mats, logs, debris and other objectionable material shall be removed as follows:

1. Grubbing shall extend to the outside excavation and fill slope lines except where tops of slopes are to be rounded. In these locations, the areas shall extend to the outside limits of slope rounding.

2. Grub where subdrainage trenches will be dug, unsuitable material removed or structures built.

3. Grub areas in which hillsides or existing embankments will be terraced.
4. Grub areas upon which embankments, foundations or other structures will be placed.
   a. Areas beneath embankments greater than 3 feet in depth shall be free from all vegetation and roots to a depth of 6 inches below the ground surface (after topsoil has been removed).
   b. For embankments 3 feet in depth or less, roots that are over 2 inches dia. shall be removed to a depth of 1 foot below ground surface.

3.03 CLEAN-UP
   A. Remove and dispose of barricades, coverings or other protections used to prevent damage to existing vegetation or improvements upon clean-up of the Work.

3.04 SCHEDULE
   A. Contractor must complete clearing and grubbing work far enough in advance of other operations to permit the placement of construction stakes. Construction schedule shall be adjusted so cleared areas are not left susceptible to erosion or sediment runoff due to weather.

3.05 ACCEPTANCE
   A. Upon completion of the site clearing, obtain Engineer's written acceptance of the extent of clearing, depth of stripping, and removal of deleterious material.

PART 4 - MEASUREMENT AND PAYMENT

1.03 MEASUREMENT
   A. Site Clearing will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

1.04 PAYMENT
   A. Site Clearing furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 31 11 50

DEMOLITION, CUTTING AND PATCHING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Demolition, removal and disposal, salvage, cutting and patching of existing construction, surface or subsurface, where shown on Plans, or as required to accommodate new work shown or specified including backfilling of excavations and depressions to restore Worksite to final grade.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 01 - General Requirements.
2. Section 31 11 00 – Site Clearing
3. Section 31 20 00 - Earthwork.
4. Section 31 50 00 - Excavation Support Systems.
5. Section 32 90 00 - Soil Erosion, Sediment Control, Topsoiling and Seeding.

1.02 SUBMITTALS

A. General

1. Submittals shall be made in accordance with Division 01 requirements.

B. Contractor shall provide a Site Demolition Plan:

1. The Site Demolition Plan shall include the following items:

   a. Location and limits of demolition.

   b. Methods and equipment to be utilized including backfilling of excavations and depressions.

   c. Shoring or other structures necessary to complete the demolition in accordance with Section 31 50 00.
d. Proposed materials and methods to be used for cutting and patching, or matching and repairing existing construction to remain.

e. Safety measures including signs, barriers, temporary walkways and hand railing.

f. Schedule for performing site demolition, cutting and patching including railroad flagging needs.

g. Haul routes and disposal sites.

h. Utility coordination plan for Contractor demolished utilities as well as utilities being demolished by others as shown in the Plans.

i. Traffic control measures or traffic plan where required by Contractor’s proposed methods in accordance with Division 01 requirements.

j. Identification of permits as required by the project environmental documents, federal, state or local agency in accordance with Division 01 requirements.

C. Contractor shall provide copies of notices, permits, certifications and authorizations:

1. Copies of demolition authorization permits and other permits as required by project environmental documents, federal, state or local agency in accordance with Division 01 requirements.

2. Delivery manifests for materials hauled and disposed by Contractor.

3. Private property owner’s release for material removed from the SCRRRA project site and deposited on private property.

   a. Releases shall absolve SCRRRA and its member agencies from any responsibility in connection with the disposal of materials on private property.

   b. Releases shall be signed by the owner(s) of the property on which the material will be deposited.

   c. Two copies of the releases shall be submitted to the Engineer for approval not more than 15 days before the start of material being deposited on private property.

4. Disposal certification for materials removed from job site indicating they have been disposed of in accordance with applicable laws and regulations.

D. Contractor shall provide material certification:
1. Indicating manufacturer and type of proposed nonshrink grout and epoxy bonding adhesive for patching or repairs to existing concrete structure to remain.

1.03 DELIVERY, STORAGE, AND HANDLING

A. General:
   1. Contractor to salvage items, designated for owner's salvage, as a functional unit.
   2. Clean, list and tag each item in a manner acceptable to the Engineer for storage.
   3. Protect salvage items from damage and deliver to location designated in the Plans or as directed by the Engineer.
   4. Salvage each item with auxiliary or associated equipment required for operation.

B. Demolished Materials:
   1. On-site burning or burial of demolished materials will not be permitted.
   2. Contractor shall take possession of all demolished materials except as noted in the Contract Documents to be salvaged.
   3. Contractor shall be responsible for disposing of demolished materials in accordance with applicable federal, state and local laws and regulations in accordance with Division 01 requirements.

C. Environmental Requirements:
   1. Cleanliness, Sweeping and Dust Control shall be maintained in accordance with Division 01 requirements.
   2. Contractor shall provide noise abatement as required by environmental permits or local agency requirements in accordance with Division 01 requirements.

1.04 SITE CONDITIONS

A. Perform preliminary investigations as required in Section 31 20 00, Earthwork and in accordance with Division 01 requirements to ascertain extent of work.

1.05 SEQUENCING AND SCHEDULING

A. Coordinate and reschedule work as required to avoid interference with other operations of SCRRRA, as identified in the Construction Documents or in accepted schedule of site demolition, cutting and patching.
PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following products and manufacturers are acceptable for nonshrink grout and epoxy bonding adhesive to be used for patching of concrete to remain after demolition:

1. Nonshrink grout:
   a. Supreme Grout by Gifford Hill.
   b. Masterflow 713 Plus by BASF Building Systems.
   c. Sika Grout 212 by Sika.

2. Epoxy bonding adhesive:
   a. Euco No.452 MV by Euclid Chemical Co.
   b. Sikadur 32, Hi-Mod by Sika Corporation.

B. Submit request for substitution in accordance with Division 01 requirements.

2.02 MATERIALS

A. Nonshrink Grout:

1. Nonmetallic, noncorrosive and nonstaining.

2. Premixed with only water to be added in accordance with manufacturer's instructions at jobsite.

3. Grout to produce a positive but controlled expansion. Mass expansion not to be created by gas liberation or by other means.

4. Minimum compressive strength at 28 days to be 6500 psi.

5. Coat exposed edges of grout with a cure/seal compound recommended by grout manufacturer.

B. Epoxy Bonding Adhesive:

1. Two component, moisture insensitive adhesive manufactured for the purpose of bonding fresh concrete to hardened concrete.

C. Other Temporary or Permanent Material:

1. Other temporary or permanent material shall be provided by the Contractor for proper execution of work in this Section.
D. Backfill Material:

1. Material used for backfill shall conform to the requirements of Section 31 20 00.

PART 3 - EXECUTION

3.01 GENERAL

A. No party other than the Contactor shall remove demolished material from SCRRA property.

B. Contractor shall perform the demolition, removal, salvage, cutting and patching including handling of demolished debris in accordance with the Contract Plans, Project Specifications and the submitted approved site demolition plan.

C. Any shoring, if required to accomplish demolition work, shall be designed and constructed in accordance with Section 31 50 00.

3.02 EXISTING STRUCTURES AND RELATED FACILITIES

A. Where demolition is indicated, remove and dispose of:

1. Existing fences as identified in the Plans.
   a. Coordinate fence removal with maintaining temporary and permanent site security.

2. Temporary fences when no longer required to protect and secure the construction site.

3. Structures in their entirety or portions to be demolished as indicated in the Plans.
   a. Exposed remaining concrete faces shall be saw cut to neat lines or finished with epoxy binder and non-shrink grout.
   b. Concrete shall be removed as required and any remaining concrete to be utilized in the finished work or left as an existing structure shall be protected from damage and finished with epoxy binder and non-shrink grout or as indicated in the Plans.

4. Obstructions in their entirety or portions of obstructions as indicated in the Plans including abandoned concrete signal foundations, footings and bases located within the right-of-way shall be demolished.

5. Removal and disposal shall be in accordance with these Specifications and the submitted and approved site demolition plan.
B. Where salvage of material or portions of structures and related facilities is indicated, material shall be carefully removed as shown in the plans for installation of new work and neatly stacked at a location approved in advance to the satisfaction of the Engineer and in accordance with the approved site demolition plan. The materials shall be left in a satisfactory condition for use by SCRRA as identified in the Plans or in future projects.

C. The Contractor shall replace or repair, at no expense to SCRRA, any existing structure or portion of existing structure or related facility designated to remain that are damaged during removal of the portions designated for demolition.

### 3.03 PAVEMENT

A. Pavement shall be demolished as indicated in the Plans and removed in accordance with the submitted and approved site demolition plan.

B. Pavement shall be removed to clean straight lines. Saw cutting of edges to be joined is required. Saw cuts shall be a minimum depth of 1-1/2 inches.

1. Portland cement concrete pavement removal shall have a second full depth relief saw cut offset 12 to 18 inches parallel to the initial saw cut unless approved otherwise.

2. If a saw cut in concrete falls within three feet of a construction joint, cold joint, expansion joint, or edge, the concrete shall be removed to the joint or edge.

C. The Contractor shall provide surface drainage of resulting surfaces following pavement removal in accordance with SCRRA Standard Specification 32 90 00.

D. The Contractor shall replace at no expense to SCRRA any existing pavement designated to remain that is damaged as a result of Contractor activities.

### 3.04 WIRING AND POLES

A. Wiring and Poles designated to be removed by the Contractor shall be removed in accordance with the Plans and the approved site demolition plan. No work shall be performed until clearance to proceed has been provided by the Engineer.

### 3.05 UTILITIES

A. Demolition of existing utilities removed by others as shown in the Plans shall be coordinated by the Contractor with the utility companies and agencies in accordance with Division 01 in accordance with the approved site demolition plan.

B. The Contractor shall cap and plug storm drain, sanitary sewer, and underdrain in accordance with the utility owner’s standard details and instructions. Cap and plug pipe and other conduits abandoned due to demolition, with approved type caps and plugs as required by the utility owners.
C. Abandoned utilities under railroad tracks shall be removed and backfilled or filled in accordance with these specifications and the project plans and technical Specifications.

3.06 BACKFILL OF DEMOLITION EXCAVATIONS

A. Any shoring used for support of demolition excavations shall be removed in accordance with Section 31 50 00 and the submitted and approved site demolition plan.

B. Excavations created by demolition activities shall be backfilled and compacted in the same manner as backfilling excavations in SCRRRA Standard Specification Section 31 20 00.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Existing facilities to be reconstructed, relaid, relocated or reset is considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section. Work of this existing facilities shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. When existing facilities are to be salvaged, no separate measurement and payment will be made for removing the facilities.

C. Removal of traffic lines and marking will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

D. Removing, salvaging, reconstructing, relocating or resetting the various types of fence will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

E. Removing, salvaging, reconstructing, relocating or resetting the various types of asphalt or concrete curb, curb and gutter will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

F. Removing, salvaging, reconstructing, relocating or resetting of signs will be measured by the unit or fraction thereof furnished and completed in accordance
with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement. Each individual sign installation will be considered one unit regardless of the number of posts or sign panels involved.

G. Removing, salvaging, reconstructing, relocating or resetting drainage facilities will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

H. Adjusting manholes and inlets to grade, reconstructing, remodeling, or abandoning will be determined as units from actual counts. Will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. When the Contract Document include separate items, and units or lump sum prices for removing, salvaging, adjusting, modifying, remodeling, abandoning, obliterating, relaying, reconstructing, relocating or resetting any of the facilities, the quantities will be paid for at the Contract unit, or lump sum price for the item of work involved.

B. This price shall be full compensation for furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals and for doing all work involved in completing the operations as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

C. Full compensation for all excavation and backfill required to remove, dispose of, salvage, relay, reset, relocate and reconstruct facilities, for which payment is not otherwise provided, shall be considered as included in the Contract unit or lump sum price paid for the items of work involved and no separate payment will be made therefor.

D. When the Contract does not include separate items for removing any of the existing facilities encountered within the area to be cleared and grubbed or the removal is not included in another item, then payment for removing the facilities shall be considered incidental to work under other payment items and no separate measurement and payment will be made to the Contractor for Work of this Section.

E. Payment requests for Demolition, Cutting and Patching shall include certificates showing legal disposal of Materials from SCRR A’s right-of-way.

END OF SECTION
SECTION 31 20 00

EARTHWORK

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Excavation, embankment fill, structural excavation and backfill, borrow and removal of unsuitable material.
   2. Structural excavation shall consist of excavation for the construction of foundations for structures, excavation for trenches for the construction of culverts, pipes and other facilities. Structural backfill shall consists of furnishing, installing, and compacting backfill material around structures.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 03 31 00 – Structural Concrete
   3. Section 31 11 00 - Site Clearing.
   4. Section 31 11 50 - Demolition, Cutting And Patching.
   5. Section 31 50 00 - Excavation Support.
   6. Section 34 11 27 - Sub-Ballast and Aggregate Base.
   7. Section 34 71 50 – Highway-Rail Grade Crossings

1.02 REFERENCES

A. ASTM International (ASTM):
   3. D1556, Standard Test Method for Density and Unit Weight of Soil In Place by the Sand Cone Method.
   4. D1557, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft (2,700 kN-m/m)).


9. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depths).

B. California Code of Regulations, Title 8, Subchapter 4, Construction Safety Orders.


D. Caltrans Section 19 - Earthwork

1.03 SUBMITTALS

A. General:

1. Submittals must be made in accordance with Division 01 requirements.

B. Plans and Procedures:

1. Submittals of plans and procedures to the Engineer must be made and approval obtained prior to commencing work for Rough Grading, temporary storage area(s) for topsoil, Excavation, Embankment Fill, Structure Excavation and Backfill, subgrade preparation, borrow (on-SCRRA property and off SCRRA property) and removal of unsuitable materials.

2. Plans shall include, as necessary, haul routes, public streets to be used, traffic control and other incidental work necessary to complete the Rough Grading, Excavation, Embankment Fill, Structure Excavation and Backfill, subgrade preparation, borrow (on-SCRRA property and off SCRRA property) and removal of unsuitable materials.

3. Contractor must submit a Rough Grading Plan, permit application and approved permits as required by project technical Specifications:

   a. Phasing of the work shall be shown.

   b. Demolition and proposed temporary erosion and sedimentation control measures shall be included.
4. Contractor must submit an Excavation and Embankment Fill Plan:
   a. Proposed excavation methods, procedure and equipment to be utilized.
   b. Information provided the Engineer does not relieve Contractor of responsibility for the successful excavation performance.

5. Contractor must submit a Structure Excavation and Backfill Plan.
   a. Proposed excavation methods, procedure and equipment to be utilized for structural work.
   b. Proposed backfill methods, procedure and equipment to be utilized for structural work.
   c. Information provided the Engineer does not relieve Contractor of responsibility for the successful structure excavation and backfill performance.

C. Certificates:
   1. Material Test Reports for products purchased and used in the project.
   2. Certification of proper disposal of demolition materials.
   3. Tickets or certification from material suppliers demonstrating compliance with Materials Tests or Specifications.
   4. Certified laboratory test reports for fill material, imported or obtained from SCRRRA property, documenting:
      a. ASTM D422, Sieve Analysis.
      b. ASTM D1557 or ASTM D4254, Moisture Density Results.
      c. ASTM D4318, liquid limit, plastic limit and plasticity index.
   5. The Engineer will determine adequacy of the test reports or certifications in accordance with the Contract Documents and may require additional testing to confirm requirements with the Specifications.

D. Product Data and Shop Plans:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

E. Samples:
1. Submit samples, soils test results, and sources of fill, backfill and borrow materials proposed for use.

2. Submit material samples when requested by the Engineer for use as confirmation of Contractor test results.

F. Miscellaneous Submittals:

1. Submit test results for density and compaction tests performed by certified test laboratory hired by the Contactor and approved by the Engineer to perform and report testing.

   a. Test results submittal shall be on a form approved in advance by the Engineer.

2. Verification documentation, in accordance with Division 01 requirements, that Contractor requested DigAlert field location of underground utilities and SCRRA Signal and Communications field location of underground railroad lines prior to starting any excavation work.

1.04 QUALITY ASSURANCE

A. Prior to commencing Work, the Contractor must examine the Contract Plans and Specifications, inspect the site, consult all available record Plans of existing Work and utilities, and note all conditions and limitations, which may influence Work required by this Section.

B. Materials not meeting the requirements of this specification must not be used in the Work.

1.05 SITE CONDITIONS

A. Contractor must execute Work under this Specification in such a manner as to minimize impact to the daily operation of the SCRRRA, vehicular and pedestrian traffic.

B. The Contractor must barricade open excavations and post with warning lights those excavations occurring on property adjacent to or within public access areas and along the SCRRRA tracks in accordance with requirements of Section 31 50 00. Operate warning lights during hours from dusk to dawn each day and as otherwise required. Warning lights shall be located to avoid shining directly into Locomotive Engineer’s eyes in oncoming trains.

C. The Contractor must protect utilities, structures and facilities designated as protect in place from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation and backfill operations.

D. The Work shall allow rainfall to drain freely at all times in accordance with project environmental requirements and permit conditions in accordance with Division 01 requirements.
1.06 ENVIRONMENTAL CONDITIONS

A. The Contractor must protect against erosion and uncontrolled run-off within and adjacent to right-of-way in accordance with the Project’s Storm Water Pollution Prevention Plan and the approved NPDES Permit in accordance with Division 01 requirements.

B. The Contractor must obtain all required permits for dewatering and legally dispose of water from dewatering operations.
   1. Comply with requirements of permits and agencies having jurisdiction over the project site in accordance with Division 01 requirements.

C. Cleanliness, Sweeping and Dust Control shall be in accordance with Division 01 requirements.

D. Contractor must provide noise abatement as required by environmental permits or local agency requirements in accordance with Division 01 requirements.

1.07 REGULATORY REQUIREMENTS

A. Furnish required excavation Plans to jurisdictional authorities and obtain permits there from. Refer to Division 01.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Structure Excavation:
   1. Excavation for the construction of foundations for structures; excavation of trenches for the construction of culverts, pipes, rods, deadmen, and cutoff walls; other excavation designated on the plans or in these specifications or in the technical provisions as structure excavation.

B. Embankment fill and backfill shall consist of suitable material from project site excavation, from other SCRRA property or off site borrow as shown in the Plans and approved by the Engineer.
   1. 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.
2. 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 SCRRA.

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

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

5. Fill and backfill material shall have plasticity index of 15 or less and a liquid limit of 30 or less and expansion index of 30 or less, except where otherwise approved by the Engineer.

6. Suitable materials from structure excavation not used as structure backfill shall be deposited as fill or backfill material.

7. Materials not meeting these requirements will be classified as unsuitable and shall be removed and legally disposed off-site by the Contractor, or as directed by the Engineer.

C. Structural Backfill:

1. Various items of work involved in furnishing, placing and compacting backfill material around structures to the lines designated on the plans or specified by the Engineer.

2. Material shall have a Sand Equivalent value of not less than 20 and shall conform to the following grading in Table 1:

<table>
<thead>
<tr>
<th>Sieve Sizes</th>
<th>Percentage Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot;</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>35-100</td>
</tr>
<tr>
<td>No. 30</td>
<td>20-100</td>
</tr>
</tbody>
</table>

3. Material shall be free of stones or lumps exceeding 3 IN in greatest dimension organic or other unsatisfactory material.
4. At locations where directed by the Engineer, the material used to backfill the outer 2 feet portion of structure backfill adjacent to pipe and culvert inlets and outlets, and structure backfill placed within 2 feet of finished grade around abutments, abutment wing walls, retaining walls, and other portions of structures shall be compacted impervious material. The impervious backfill shall meet the material requirements in Table 1 except there shall be 15 percent plus or minus 2 percent minus 200 sieve material present and as determined by the Engineer to be suitable for such purpose. The Sand Equivalent requirement shall not apply to the impervious material used for structure backfill.

5. When material from Structure Excavation is unsuitable for use as structure backfill, the Engineer may require the Contractor to:
   a. Use other material covered by the Contract if such substitution involves Work that does not differ materially from what would otherwise be required. No additional compensation will be allowed.
   b. Substitute selected material available from the project site. No additional compensation will be allowed.
   c. Use Controlled Density Fill (CDF).
   d. Obtain material elsewhere from Contractor sources in accordance with Division 01.

6. When required by the Plans or submitted as an option and approved by the Engineer in advance, controlled density fill (CDF) or slurry cement backfill, a self compacting, cementitious flowable material requiring no vibration or tamping to achieve consolidation, may be used. The Contractor must submit a mix design in writing to the Engineer for approval. The design shall provide:
   a. A minimum 28-day strength of 50 psi and a maximum 28-day strength not to exceed 300-psi.
   b. Consistency shall be flowable (3 inches to 10 inches slump).
   c. The CDF materials shall meet material properties and testing contained in Section 34 80 41.

7. Pervious Backfill Material shall be placed behind bridge abutments, wing walls and retaining walls as shown on the plans and in accordance with these Specifications.
   a. Material shall consist of gravel, crushed gravel, crushed rock, natural sands, manufactured sand or combinations thereof.
b. Pervious backfill material shall be placed in layers along with and by the same methods specified for structural backfill. Pervious backfill material at any one location shall be approximately the same grading, and at locations where the material would otherwise be exposed to erosion shall be covered with at least a one foot layer of earthy material approved by the Engineer.

c. Pervious backfill material, except for sacked material at wall drain outlets, shall conform to the following grading requirements:

| Table 2, Pervious Backfill Material |
|-----------------------------------|----------------|
| Sieve Sizes | Percentage Passing |
| 2 inches | 100 |
| No. 50 | 0 - 100 |
| No. 100 | 0 - 8 |
| No. 200 | 0 - 4 |

D. Aggregate Base and Crushed Miscellaneous Base:

1. Aggregate Base material shall conform to the requirements set forth in Section 34 11 27.

2. Crushed Miscellaneous Base, CMB, shall consist of broken and crushed asphalt concrete or Portland cement concrete and may contain crushed aggregate base or other rock materials. The material shall be free of any detrimental quantity of deleterious material and contain no more than 15 percent material retained on the No. 4 sieve. Material shall not contain more than 3 percent brick by weight of dry sample.

3. Crushed Miscellaneous Base shall conform to the following grading requirements:

| Table 3, Crushed Miscellaneous Base |
|-----------------------------------|----------------|
| Sieve Size | Percentage Passing Sieve |
| Coarse | Fine |
| 2 inches | 100 | |
| 1-1/2" | 85 - 100 | 100 |
| 3/4" | 50 – 85 | 85 - 100 |
| 3/8" | 55 - 75 | |
| No. 4 | 25 - 45 | 25 - 60 |
| No. 30 | 10 – 25 | 10 - 30 |
| No. 200 | 2 - 9 | 2 - 9 |
| ASTM C 131 Test Grading | A | B |

4. Crushed Miscellaneous Base shall only be used in paving areas.
E. Geotextile Filter Fabric:

1. Geotextile Filter Fabric shall be as specified in the Project Specific Technical Specifications.

PART 3 - EXECUTION

3.01 PROTECTION

A. Protect existing surface and subsurface features on-site and adjacent to site as follows:

1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing items indicated to remain in place.

2. Protect and maintain bench marks, monuments or other established reference points and property corners.
   a. If disturbed or destroyed, replace at own expense to full satisfaction of Owner and controlling agency.
   b. Property corners, if disturbed or destroyed, shall be reset in accordance with applicable surveying law for the State of California after completion of rough grading and prior to commencing final excavation or grading operations.

3. Verify location and protection of existing utilities.
   a. Omission or inclusion of utility items does not constitute non-existence or definite location. Locations of utilities shown on the Plans are provided for the Contractor’s information only and the Contractor is responsible for verifying the location of all utilities to his own satisfaction.
   b. Secure and examine local utility records for location data. In accordance with Division 01, the Contractor must make all attempts to locate utilities including potholing if necessary prior to commencing excavations. If utilities cannot be located, the Contractor must first pothole anticipated location(s) by hand methods. When located, complete excavation with caution to prevent damage.
      1) When utility lines not known or indicated on the Plans are encountered within the area of operations, the Contractor must notify the Engineer and utility owner immediately. Measures shall be taken to protect the utility and prevent damage to the utility.
   c. Take necessary precautions to protect existing utilities from damage due to any construction activity.
d. Repair damages to utility items at own expense.

e. In case of damage, notify Engineer at once so required protective measures may be taken.

f. SCRRA’S underground signal lines will be located by the SCRRA in accordance with Division 01.

g. Excavations created for location of underground utilities shall be backfilled in accordance with the following:
   1) Backfill material shall meet the criteria established for embankment fill material. The upper 12 inches of the embankment fill shall be compacted to 95 percent relative density per ASTM D1557 and the layer below 12 inches from the top of the compacted fill shall be compacted to 90 percent relative density per ASTM D1557 and shall contain no materials greater than 3 inches in maximum dimension.
   2) Place the uppermost 12 inches of compacted fill in two lifts of 6 inches (compacted). Each lift shall be compacted to 95 percent relative density per ASTM D1557 and shall contain no materials greater than 1 inch in maximum dimension.

h. Any excavation that exposes or potentially could expose an existing underground utility or structure indicated as “protect in place,” “to remain” or similar indication, or any unknown utility or structure found and deemed requiring special methods by the Engineer, shall be classified as a structural excavation and backfill for purposes of replacing and compacting fill. This shall be at no additional cost to SCRRA.
   1) The Contractor shall not disrupt any service until utility owner and the Engineer has determined the required action on such lines.

4. Maintain free of damage, existing sidewalks, structures, and pavement, not indicated to be removed in the Plans.

   a. Any item known or unknown or not properly located that is inadvertently damaged shall be repaired to original condition at no expense to SCRRA.

5. Provide full access to public and private premises, fire hydrants, street crossings, sidewalks and other points as designated by Owner to prevent serious interruption of travel and emergency services.

6. The Contractor must take precautions to prevent damage to existing foundations and structures protecting them in place without undermining or causing movement.
7. Maintain stockpiles and excavations in such a manner to prevent movement or damage to structures on-site or on adjoining property that are not noted in plans as being demolished.

8. At all times during the execution of this Work, the Contractor must maintain safe and stable excavations. Where required by California Construction Safety Orders, the Contractor must employ side slope layback, benching, or shoring. Required excavation support methods shall be in accordance with Section 31 50 00.

B. Water and Storm Drainage Removal:

1. The Contractor must provide, operate, and maintain an adequate system to remove water throughout the excavation and construction operation as necessary.

2. Obtain all permits for and legally dispose of water dewatering operations to facilitate construction. Comply with requirements of the permits, project environmental conditions and agencies having jurisdiction.

3. Elements of the system shall be located to allow continuous water removal without interfering with other construction activities.

C. Salvageable Items: Carefully remove items to be salvaged, and store as directed by the Engineer in accordance with Section 31 11 50.

D. Dispose of waste materials, legally, off site.

1. Burning, as a means of waste disposal, is not permitted.

3.02 SITE EXCAVATION AND GRADING

A. The work includes all operations in connection with excavation, borrow, construction of fills and embankments and structures, rough grading, and disposal of excess materials in connection with the preparation of the site(s) for construction of the railroad roadbed or other facilities.

B. Excavation and Grading: Perform as required by the Contract Plans.

1. Prior to rough grading, the Contractor must complete clearing and grubbing in accordance with Section 31 11 00.

2. Contract Plans may indicate both existing grade and finished grade required for construction of Project.

   a. Stake all units, structures, piping, fills and cuts, roads, parking areas and walks and establish their elevations upon completion of site clearing in accordance with SCRRRA Standard Specification 31 11 00.

   b. Perform other construction staking work required.
3. The Contractor must not place any embankment fill or sub-ballast the ground surface for embankment fills or base of excavations without prior acceptance of the excavated and rough graded areas by the Engineer.

4. The Contractor must perform rough grading as indicated to achieve the bottom elevation for the embankment. This work shall be considered incidental to construction of embankment cuts and fills.

5. Preparation of ground surface, rough grading, for embankment cuts or fills:
   a. Before embankment fill is started or subballast placed, scarify to a minimum depth of at least 6 inches and up to 18 inches (if necessary to reach the specified density) in all proposed embankment cut and fill areas.
      1) Moisture content shall be brought to 2.0 percent above optimum and relative compaction of 90 percent relative density per ASTM D1557 reached prior to placing any embankment fill if more than 12 inches of fill required.
      2) Moisture content shall be brought to 2.0 percent above optimum and relative compaction of 95 percent relative density per ASTM D1557 reached prior to placing any embankment fill if 12 inches or less of fill is required or sub-ballast is to be placed directly on the prepared base.
   b. Where embankment fill is to be constructed against an existing ground surface that is steeper than one vertical to four horizontal, plow surface in a manner to bench and break up surface so that fill material will key into the existing surface.
      1) Benches shall have a horizontal dimension of not more that 6 feet and a vertical rise of not more than 2 feet.
      2) Benches cut into the slope shall not be allowed to remain unsupported overnight.
      3) Benches cut within 12 feet of the track centerline shall only be created during train free periods and shall be immediately backfilled and compacted unless shoring designed in accordance with SCRRRA's Excavation Support Guidelines, constructed in accordance with Section 31 50 00, and these Specifications is installed.

6. Preparation of ground surface for foundations or footings.
   a. Before constructions of the foundation or footing are started, scarify a minimum of 6-inches.
1) Moisture content shall be brought to 2.0 percent above optimum and relative compaction of 95 percent relative density per ASTM D1557 reached prior to placing reinforcing steel for any foundation or footing.

7. In areas where unsuitable materials are encountered in the embankment cut or fill footprint, the Engineer may direct removal and replacement with suitable materials placed and compacted in accordance with these Specifications in accordance with Section 4, Measurement and Payment.

8. Fill and backfill shall be placed as promptly as work permits but not until completion of the following:
   a. Approval by the Engineer of the embankment cut or embankment fill base preparation.
   b. Recording of final location, elevation, and limits of any structure, utility or other underground feature that will remain in place and be covered by the embankment.
   c. Removal of any trash and debris.
   d. Removal of shoring and bracing where applicable and as directed by the Engineer.

9. Protection of finished grade:
   a. During construction, shape and drain embankment and excavations.
   b. Maintain ditches and drains to provide drainage at all times. Protect newly graded areas from erosion.
   c. Protect graded areas against action of elements prior to acceptance of work.
   d. Contractor must keep graded areas free of trash and debris until final inspection and acceptance by the Engineer.
   e. Reestablish grade where settlement or erosion occurs.
   f. Contractor must not operate equipment supported directly on the roadbed unless it can be demonstrated through compaction testing to the Engineer’s approval that the equipment selected can be supported without creating softening, rutting or degradation of the roadbed.
   g. Contractor must remove any excess material that was delivered and not used for the Project at its own expense.

C. Borrow:
1. Provide necessary amount of approved fill, from material obtained from SCRRRA property or imported, compacted to density equal to that indicated in this Specification.

2. Fill material to be approved by Engineer prior to placement.

D. Construct embankment and structure cuts and fills as required by the Contract Plans:

1. Construct embankment cuts and fills at locations and to lines of grade indicated.
   a. Completed embankment fill and cut shall correspond to shape of typical cross section or contour indicated regardless of method used to show shape, size, and extent of line and grade of completed work.

2. Provide approved fill material for embankment fill or backfill which is free from roots, organic matter, trash, frozen material as follows:
   a. Ensure that stones larger than 3 inches are not placed in upper 12 inches of fill or embankment.
   b. Do not place material in layers greater than 8-inches loose thickness.
   c. Place layers horizontally and compact each layer prior to placing additional fill to a minimum of 90 percent relative compaction per ASTM D1557.

3. Provide approved fill material for structural fill or backfill which is free from roots, organic matter, trash, frozen material, and stones as follows:
   a. Ensure that stones larger than 3 inches are not placed against any concrete or other foundation material or used as structural fill or backfill.
   b. Do not place material in layers greater than 8 inches loose thickness.
   c. Place layers horizontally and compact each layer prior to placing additional fill to a minimum of 95 percent relative density per ASTM D1557.

4. Compaction shall be by equipment approved by the Engineer to obtain specified density.
   a. Control moisture for each layer as necessary to meet requirements of compaction.
b. Before compaction, each layer shall be moistened or aerated as necessary to provide the optimum moisture content.

c. Compaction shall not result in significant rutting under the action of the compactor on the final passes on a lift.

d. The compaction process must extend the full width of the embankment fill or cut section for the layer being worked.

5. Contractor must properly place and compact all embankment fill or structural fill or backfill materials. Deficiencies resulting form insufficient or improper compaction of such material shall be corrected by the Contractor throughout the Contract period. When specified compaction density is not being obtained or subgrade surface damaged by equipment, Contractor must:

a. Stop placing additional fill.

1) Material in place may be scarified, water content adjusted and area rerolled until required compaction is obtained.

2) Alternatively, Contractor may remove not fully compacted material and replace with different material at no additional cost to SCRRA.

3) Contractor may proposed other means and methods to the Engineer for approval.

b. If softening of the subgrade surface takes place under construction traffic to a degree unsatisfactory to the Engineer, Contractor must rework or remove and replace the material, recompacting and grading as required at no additional cost to SCRRA.

c. If a fill material is too wet:

1) It may be scarified or disked and aerated until the proper water content is attained.

2) With approval of the Engineer, Contractor may blend drier soil with the wet fill to achieve a water content suitable for compaction.

3) Contractor may propose other means and methods to the Engineer for approval.

3.03 COMPACTION EQUIPMENT

A. Contractor must determine the type, size and weight of the compaction equipment best suited to perform the work at hand. Select and control the lift (layer) thickness within the Specifications with approval of the Engineer. Proper
control over the moisture content of the material shall be maintained to obtain required compaction results.

B. In areas inaccessible to conventional compactors, or where maneuvering space is limited, approved impact rammers, small drum vibrators, vibratory plate, or pneumatic button head compaction equipment may be used with layer thickness not to exceed 6 inches before compaction.

C. Compaction by jetting or flooding with water is not allowed.

3.04 ROCK EXCAVATION

A. Rock excavation shall be as specified in the Project Specific Specifications.

3.05 USE OF EXPLOSIVES

A. Blasting with any type of explosive is prohibited.

3.06 FIELD QUALITY CONTROL/QUALITY ASSURANCE

A. Include in bid price for earthwork the cost of inspection services indicated herein as being performed by the Contractor’s Soils Engineer.

1. The Contractor must use a certified testing laboratory that is approved in advance by the Engineer.

2. Included are all retests required by the Engineer to confirm successful compaction at failed test locations.

B. Moisture density relations, to be established by the Contractor’s Soils Engineer, are required for all materials to be compacted. Samples of soils shall be provided at no additional cost for verification testing by SCRRRA when required by the Engineer.

C. Extent of compaction testing will be as necessary to assure compliance with Specifications.

1. On-site density tests in accordance with ASTM D6938 shall be used to demonstrate that proper compaction has been obtained.

2. Visual observation may be used to augment on-site density tests. Visual inspection in no way relieves Contractor of responsibility to perform on-site density testing.

3. Density testing must be performed in the following frequency:

   a. At least one density test must be performed for each 200 cubic yards of embankment compacted fill.

   b. At least one density test must be performed in the prepared subgrade in embankment cuts every 500 feet.
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c. At least one density test is to be performed for each 30 cubic yards of compacted structural backfill.

d. Density tests shall be taken in areas representative of compactive efforts and not in areas of equipment traffic.

4. SCRRRA will perform Quality Assurance (verification) testing for on-site density as determined by the Engineer.

   a. Testing will be by an independent certified soils testing laboratory.

   b. Retests required due to Contractor not complying with the density requirements must be paid for by the Contractor as a deduction from payment.

D. Give minimum of 24 hours advance notice to the Engineer when ready for compaction or subgrade testing observation and inspection.

E. Should any compaction density test or subgrade inspection fail to meet Specification requirements, perform corrective work as necessary including but not limited to rerolling and manipulation of moisture. Additional compaction testing will be required to determine that corrective work provides compaction in the failed area meeting requirements of these Specifications.

F. Contractor must provide a record of compaction testing results including corrective actions taken if necessary on the approved form to the Engineer.

G. Contractor’s corrective work to meet compaction requirements and retesting resulting from failing compaction density tests shall be at no additional cost to SCRRRA.

3.07 EXCAVATION, FILLING, AND BACKFILLING FOR STRUCTURES

A. General:

1. The backfilling of openings dug for Structures shall be a necessary part of and incidental to the excavation for the Structure.

2. The Engineer may require the Contractor to selectively remove and stockpile any usable material excavated for a Structure.

   a. If material meets the requirements for Pervious Backfill Material, Table 2, for walls it may replace gravel as wall or abutment backfill.

3. Stockpiled material shall be protected with plastic sheeting or by some other method as approved by the Engineer from contamination and weather damage.
a. Too wet or contaminated material caused by failure of the protection method shall be disposed of by the Contractor and replaced with an equal amount of suitable material at no expense to SCRRRA unless the project construction schedule allows for Contractor to propose a different method for Engineer's approval.

4. All costs for supplying, if necessary, storing, protecting, rehandling and placing stockpiled material shall be included in the unit Contract price for Structure Excavation.

5. In this Section of the Specifications, the word "foundations" includes footings, base slabs, foundation walls, mat foundations, grade beams, piers and any other support element placed directly on soil or deep structural foundations such as piling or drilled shafts.

6. In the paragraphs of this Section of the Specifications, the word "soil" also includes any type of rock subgrade that may be present at or below existing subgrade levels.

B. Excavation Requirements for Structures:

1. General:

   a. Do not commence excavation for foundations for structures until Engineer approves Contractor's submittals of tests or information indicating one of the following as applicable:

      1) Density and moisture content of compacted fill material at structure site meets requirements of specifications.

      2) Site surcharge or mass fill material can be removed due to meeting requirements in the Construction Documents from entire construction site or portion thereof.

      3) Surcharge or mass fill material has been removed previously from construction area or portions thereof.

   b. Engineer grants approval to begin excavations.

2. Dimensions:

   a. Excavate to elevations and dimensions indicated or specified.

   b. Allow additional space as required for construction operations, working space, formwork, damproofing, waterproofing and inspection of foundations.
3. Removal of obstructions and undesirable materials in excavation includes, but is not necessarily limited to, removal of old foundations, existing construction, unsuitable subgrade soils, expansive type soils, and any other materials which may be concealed beneath present grade, as required to execute work indicated on Contract Plans.

   a. If undesirable material and obstructions are encountered during excavation remove material to a depth where suitable materials are found or compacted material meeting requirements of Table 1 Structural Backfill provides a stable subgrade and meets compaction requirements.

   b. Unsuitable material removed below foundation elevations shall be replaced with material meeting requirements of Table 1, Structural Backfill and compacted in layers not exceeding 6 inches in depth to 95 percent of relative density per ASTM D1557.

   c. Engineer will approve additional excavation for unsuitable materials below the foundation. Additional work will be paid for in accordance with Part 4, Measurement and Payment of these Specifications.

4. Do not carry excavations lower than shown for foundations except as directed by the Engineer.

   a. If any part of excavations is carried below required depth without authorization, maintain excavation and start foundation from excavated level with concrete of same strength as required for superimposed foundation, and no extra compensation will be made to Contractor therefore.

5. Notify Engineer as soon as excavation is completed in order that excavated structure subgrades may be inspected.

   a. Do not commence further construction until subgrade under compacted fill material, under foundations, under floor slabs-on-grade, under equipment support pads, and under retaining wall footings as applicable has been inspected and approved by the Engineer as being free of undesirable material, being of compaction density required by this Specification as shown by the compaction tests, and being capable of supporting the allowable foundation design bearing pressures and superimposed foundation, fill, and building loads to be placed thereon.

   b. The Engineer must be given the opportunity to inspect subgrade below fill material both prior to and after subgrade compaction.
c. Place concrete for foundations, retaining wall footings, floor slabs-on-grade, and equipment support pads as soon as weather conditions permit after excavation is completed, inspected, and approved and after forms and reinforcing are inspected and approved.

d. Place fill material after removal of forms in accordance with time frame provisions of Section 34 80 41.

e. Before concrete or fill material is placed, protect approved subgrade from becoming loose, wet, frozen, or soft due to weather, construction operations, or other reasons.

6. Dewatering:

a. Where groundwater is, or is expected, to be encountered during excavation, install a dewatering system to prevent softening and disturbance of subgrade below foundations and fill material. The dewatering system shall be designed to allow foundations and fill material to be placed in the dry, and to maintain a stable excavation side slope.

b. Groundwater levels shall be maintained at least 3 feet below the bottom of any excavation.

c. Review soils investigation before beginning excavation and determine where groundwater is likely to be encountered during excavation.

d. Employ a hydrologist for selecting and designing the dewatering system.

1) Such design shall include field maintenance instructions for Contractor’s personnel.

e. Keep dewatering system in operation until dead load of structure exceeds possible buoyant uplift force on structure.

f. Dispose of groundwater to an area which will not interfere with construction operations or damage existing construction.

1) Install groundwater monitoring wells as necessary.

2) Obtain dewatering permits in accordance with Project Environmental requirements.

g. Upon completion of excavation and structure foundation work, do not turn off dewatering system in a manner that the upsurge in water weakens the subgrade.

7. Subgrade stabilization:
a. If subgrade under foundations, fill material, floor slabs-on-grade, or equipment support pads is in a frozen, loose, wet, or soft condition before construction is placed thereon, remove frozen, loose, wet, or soft material and replace with approved compacted material as directed by the Engineer. Such additional work will be measured and paid for in accordance with Section 4.0, Measurement and Payment.

b. Provide compaction density of replacement material as stated in this Specification Section.

c. Loose, wet, or soft materials, when approved by the Engineer, may be stabilized by a compacted working mat of well graded crushed stone meeting requirements for Table 1, Structural Backfill.

    1) Compact stone mat thoroughly into subgrade to avoid future migration of fines into the stone voids.

d. Method of stabilization shall be as approved by the Engineer.

e. Do not place further construction on the repaired subgrades, until the subgrades have been approved by the Engineer.

8. Protection of structures:

a. Contractor must take precautions to protect new and existing structures from becoming damaged due to construction operations or other reasons.

b. Contractor must take precautions to protect subgrade under new and existing foundations from becoming wet and undermined during construction due to presence of surface or subsurface water or due to construction operations.

9. Shoring:

a. Shore, sheet pile, slope, or brace excavations as required to prevent them from collapsing in accordance with Section 31 50 00.

b. Remove shoring as backfilling progresses but only when the area where shoring is being removed is stable and safe from caving or collapse.

10. Drainage:

a. Control grading around structures so that ground is pitched to prevent water from running into excavated areas or damaging structures.
b. Maintain excavations where foundations, floor slabs, equipment support pads or fill material are to be placed free of water.

c. Provide pumping required to keep excavated spaces clear of water during construction in accordance with Subsection 3.07.B.6, Dewatering, of these Specifications.

d. Should any groundwater, not noted in the Construction Documents be encountered in the excavation, notify Engineer.

e. Provide free discharge of water by trenches, pumps, wells, well points, or other means as necessary and drain to point of disposal that will not damage existing or new construction or interfere with construction operations in accordance with Paragraph 3.07.B.6, Dewatering, of this Section.

11. Frost protection:

a. Do not place foundations, slabs-on-grade, equipment support pads, or fill material on frozen ground.

b. When freezing temperatures may be expected, do not excavate to full depth indicated, unless foundations, floor slabs, equipment support pads, or fill material can be placed immediately after excavation has been completed and approved.

c. Protect excavation from frost if placing of concrete or fill is delayed.

d. Where a concrete slab is a base slab-on-grade located under and within a structure that will not be heated, protect subgrade under the slab from becoming frozen until final acceptance of the Project by the Owner.

e. Protect subgrade under foundations of a structure from becoming frozen until structure is completed and heated to a temperature of at least 50 deg. F.

C. Structural Fill and Backfill below Foundations, Base Slabs, Floor Slabs, Equipment Support Pads and Piping:

1. General:

a. Subgrade to receive fill or backfill shall be free of undesirable material as determined by the Engineer and scarified to a depth of 6 inches and compacted to density specified herein.

b. Surface may be stepped by not more than 12 inches per step or may be sloped at not more than 2 percent.
c. Do not place any fill or backfill material until subgrade under fill or backfill has been inspected and approved by the Engineer as being free of undesirable material and compacted to specified density.

2. Obtain approval of fill and backfill material and source from the Engineer prior to placing the material.

3. Granular fill under floor slabs-on-grade: Place all floor slabs-on-grade on a minimum of 6 inches of material meeting the requirements of Table 1, Structural Backfill, unless otherwise indicated.

4. Vapor barrier: Install a continuous vapor barrier under floor slabs-on-grade as required by Section 07 11 19 and shown on Contract Plans.

5. Fill and backfill placement:
   a. Prior to placing fill and backfill material, optimum moisture and maximum density properties for proposed material shall be submitted to the Engineer for approval.
   b. Place fill and backfill material in 6 inches lifts as necessary to obtain required compaction density.
   c. Compact material by means of equipment of sufficient size and proper type to obtain specified density.
   d. Use hand operated equipment for filling and backfilling immediately next to walls.
   e. Do not place fill and backfill when the temperature is less than 40 deg. F and when subgrade to receive fill and backfill material is frozen, wet, loose, or soft.
   f. Use vibratory equipment to compact granular material; do not use water.

6. Where fill material is required below foundations, place fill material, conforming to the required density and moisture content, outside the exterior limits of foundations located around perimeter of structure the following horizontal distance whichever is greater:
   a. As required to provide fill material to indicated finished grade.
   b. 5 feet.
   c. Distance equal to depth of compacted fill below bottom of foundations.
   Or
   d. As directed by the Engineer.
D. Filling and Backfilling Outside of Structures.

1. This paragraph of this Specification applies to fill and backfill placed outside of structures above bottom level of both foundations and piping but not under paving.

2. Provide material, in accordance with Table 1, Structural Backfill as approved by the Engineer for filling and backfilling outside of structures.

3. Fill and backfill placement:
   a. Prior to placing fill and backfill material, determine optimum moisture and maximum density properties for the proposed material and submit to the Engineer for approval.
   b. Place fill and backfill material in 6-inch lifts as necessary to obtain required compaction density.
   c. Compact material with equipment of proper type and size to obtain density specified.
   d. Use only hand operated equipment for filling and backfilling within a distance of 5 feet from walls, retaining walls and other concrete structures.
   e. Do not place fill or backfill material when temperature is less than 40 deg. F and when subgrade to receive material is frozen, wet, loose, or soft.
   f. Use vibratory equipment for compacting granular material; do not use water except as a means to reach optimum moisture.

4. Backfilling against walls or other concrete structures:
   a. Do not backfill around any part of structures until each part has reached specified 28-day compressive strength and backfill material has been approved by the Engineer.
   b. Do not start backfilling until concrete forms have been removed, trash removed from excavations, pointing of masonry work, concrete finishing, dampproofing and waterproofing have been completed.
   c. Bring backfill and fill up uniformly around the structures and individual walls, piers, or columns.

E. Backfilling Outside of Structures Under Piping or Paving:
1. When backfilling outside of structures requires placing backfill material under piping or paving, the material shall be placed from bottom of excavation to underside of piping or paving at the density required for fill under piping or paving as indicated in this Section.

2. This compacted material shall extend transversely to the centerline of piping or paving a horizontal distance each side of the exterior edges of piping or paving equal to the depth of backfill measured from bottom of excavation to underside of piping or paving.

3. Provide special compacted bedding or compacted subgrade material under piping or paving as required by other Sections of these Specifications.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Excavation and backfill will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Measurement will be by type of excavation or backfill:

1. Excavation.
2. Embankment fill and borrow used as embankment fill.
3. Structural Excavation and Structural Backfill.
4. Removal of unsuitable material and backfill with approved suitable material.

C. Materials excavated outside of the designated sections or from borrow pits will not be measured. When the project is constructed essentially to the dimensions shown on the plans no further measurement will be required, and payment will be made for the quantities shown in the contract for the various bid items involved. If disagreement exists between the Contractor and the Engineer as to the accuracy of the plan quantities, either party shall, before any work is started which would affect the measurement, have the right to request in writing and thereby cause the quantities involved to be measured. If measured quantities do not reveal a discrepancy when compared to plan quantities, the Contractor must pay for the cost of the Engineer to perform measurements and calculations of quantities.
D. Embankment of the various types, as specified, will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement. Embankment will be measured in the space occupied within the limits of lines and slopes described in the typical sections and cross sections as defined in the plans and contract documents. No payment will be made for the volume of material bladed off the top of roadway embankments outside of the roadbed limits. No allowance for shrinkage or compaction will be made. If disagreement exists between the Contractor and the Engineer as to the accuracy of the plan quantities, either party shall, before any work is started which would affect the measurement have the right to request in writing and thereby cause the quantities to be measured. If measured quantities requested by the Contractor do not differ from plan quantities, then the Contractor must pay the Engineer’s costs to verify measurements of quantities.

E. When, in the judgment of the Engineer, it is impracticable, because of mixture of materials, to measure the actual unit content of each kind of material the Contractor and the Engineer shall agree upon payment provisions prior to proceeding with work. The Engineer will, from time to time, make such measurements as will best aid him in arriving at a just and equitable conclusion as to the proper percentage of the materials of the different classifications in the entire excavation, and he will so separate and classify the different materials.

F. Structural Excavation, Structure Backfill and Pervious Backfill material will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Excavation will be paid for at the contract unit price, as listed on the Schedule of Quantities and Prices, of excavation of proper classification within the limits of lines and slopes described in the typical sections and cross sections as defined in the plans and Contract Documents. This price shall be full compensation for furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals necessary for excavating, loading, transporting, and depositing materials in embankment, spoil bank, stockpile, or other designated location by whatever method is adopted, including all permission/permitting for haul operations.

B. Embankments will be paid for at the contract unit price, as listed on the Schedule of Quantities and Prices, of embankment of proper type within the limits of lines and slopes described in the typical sections and cross sections as defined in the plans and Contract Documents. This price shall be full compensation for furnishing all labor, materials, tools, equipment, supplies, water for compaction, supervision, and incidentals necessary for excavating, loading, transporting, and depositing borrow material when required; loading, transporting, and depositing
select material from stockpile when required; loading, transporting, and distributing water; spreading, aerating if necessary, and compacting the embankment material; and finishing the embankment sections to the designated line and grades.

C. Structural backfill and pervious backfill material will be paid for at the contract unit price, as listed on the Schedule of Quantities and Prices, of material within the limits of lines and slopes described in the typical section and cross sections as defined in the Plans and Contract Documents. This priced shall be full compensation for furnishing all labor, material, tools, equipment, supplies water for compaction, supervision and tools necessary for backfilling structures in accordance with these Specifications and the designated lines and grades in the Plans.

D. Removal of unsuitable material and backfill with approved suitable material will be paid for at the contract unit price per unit of material within the limits of lines and slopes agreed upon by the Contractor and Engineer and measured as applicable. This price shall be full compensation for furnishing all labor, material, tools, equipment, supplies water for compaction, supervision and tools necessary for excavating and backfilling areas of unsuitable material in accordance with these Specifications.

END OF SECTION
SECTION 31 50 00
EXCAVATION SUPPORT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Minimum requirements for excavation and temporary excavation support adjacent to railroad tracks.
      a. Limitations on construction activities.
      b. Installation, monitoring and removal requirements for temporary excavation support systems.
      c. Design, submittal and review requirements for excavations and temporary excavation support.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 03 21 00 – Reinforcing Steel.
   4. Section 03 31 00 – Structural Steel.
   5. Section 31 11 00 - Site Clearing.
   6. Section 31 11 50 - Demolition, Cutting and Patching.
   7. Section 31 20 00 - Earthwork.
   8. Section 32 90 00 - Soil Erosion, Sediment Control, Topsoiling and Seeding.
   9. Section 34 80 21 - Piling.
   10. Section 32 12 00 - Hot Mix Asphalt (HMA).
   11. Section 34 80 43 - Precast & Prestressed Concrete for Railroad Bridges.
   12. Section 34 80 51 - Structural Steel for Railroad Bridges.
1.02 REFERENCES

A. SCRRA Excavation Support Guidelines.

1.03 SUBMITTALS

A. General:

1. Submittals must be made in accordance with Division 01 requirements.

B. Contractor’s Superintendent:

1. The Contractor must submit the company, contact information (address, telephone and email), qualifications and record of relevant experience for the Superintendent in charge of the excavation support work to SCRRA for review and acceptance at least 30 days prior to construction.

C. Contractor’s Engineer:

1. Submit the name, company, contact information (address, telephone and email), qualifications and record of relevant experience for the proposed Contractor’s Engineer to SCRRA for review and acceptance at least 30 days prior to construction.

D. Design:

1. Unless otherwise approved by SCRRA, all projects will include detailed design of excavations and temporary excavation support within the Contract Documents (Plans, Specifications and Estimates).

2. Where detailed design of excavations and temporary excavation support is included in the Contract Documents, design validation by the Contractor and submittal of design calculations will not be required for excavations and temporary excavation support constructed in conformance with the Contract Documents. The Contractor must submit a written affidavit stating that all aspects of the excavation and shoring will be constructed in accordance with the Contract Documents.

3. Any deviation or modification to the design, details or construction phasing of excavations and temporary excavation support from that shown in the Contract Documents shall require pre-approval prior to construction. Perform and submit design calculations in accordance with the SCRRA Excavation Support Guidelines for any proposed deviation or modification to the Contract Documents.

4. For alternate design of excavations and temporary excavation support by the Contractor, perform design and provide all required submittals in conformance with the SCRRA Excavation Support Guidelines, including the SCRRA Shoring Submittal Design Checklist and the Design Exception Form, as applicable.
5. Where detailed design of excavations and temporary excavation support is not included in the Contract Documents, perform and submit design calculations in accordance with the SCRRRA Excavation Support Guidelines.

E. Plans:

1. Prepare and submit detailed Plans of excavation limits, temporary excavation support system(s) and all construction phasing and structural details required for the Work. Clearly show any deviations or modifications of excavations and temporary excavation support from that shown in the Contract Documents. Plans must be provided in accordance with the SCRRRA Excavation Support Guidelines.

F. Site Specific Work Plan (SSWP):

1. At least 30 days prior to construction, submit a complete SSWP in accordance with the SCRRRA Excavation Support Guidelines and Section 01 14 00, Work Restrictions, including, but not necessarily limited to:
   b. Construction procedures, materials, equipment and crews).
   c. Construction schedule.
   d. Contingency plans.

G. Construction Verification:

1. The Contractor must submit a letter to SCRRRA confirming that the excavation and temporary shoring system has been inspected and verified to conform with the Contract Documents, approved working Plans and accepted field modifications and design variances in accordance with the SCRRRA Excavation Support Guidelines. The letter must be signed and sealed by the Contractor's Engineer who is a licensed Professional Engineer in the State of California.

H. Track Monitoring Plan:

1. The Contractor must submit a detailed monitoring plan, including Plans and procedures for inspection and surveying. The monitoring plan shall comply with the Contract Documents, approved working Plans and the SCRRRA Excavation Support Guidelines.

1.04 QUALITY ASSURANCE

A. Engineer in Responsible Charge:
1. Excavations and temporary excavation support shall be designed by a licensed Professional Engineer in the State of California, civil or structural, with the requisite qualifications described in the SCRRRA Excavation Support Guidelines.

2. Review and acceptance of submittals by SCRRRA will not relieve the Engineer in Responsible Charge of responsibility for the safe design of the temporary shoring system, including responsibility for errors and omissions in submittals.

B. Contractor:

1. Qualifications of the Contractor’s Superintendent who will be responsible for excavation support system installation and removal must exceed the minimum experience record described in the SCRRRA Excavation Support Guidelines. The Superintendent’s qualifications will be subject to review and acceptance by SCRRRA.

2. Excavation or construction of excavation support systems shall not proceed until the Contractor meets SCRRSA safety training requirements, obtains a Right-of-Entry agreement (for construction by third parties), and gains acceptance of a Site Specific Work Plan (SSWP) from SCRRRA.

3. The Contractor must retain a Contractor’s Engineer to verify construction of excavations and temporary excavation support in conformance with the Contract Documents and approved Working Plans. The Contractor’s Engineer must be a licensed Professional Engineer in the State of California, civil or structural, and meet the same qualifications described in the SCRRRA Excavation Support Guidelines as the Engineer in Responsible Charge for design of the excavation support system.

4. Review and acceptance of submittals by SCRRRA will not relieve the Contractor of responsibility for the safe design and construction of the temporary shoring system, including responsibility for errors and omissions in submittals and construction deviations from accepted design plans. Excavation safety shall be the responsibility of the Contractor performing the shoring installation and excavation.

1.05 SITE CONDITIONS

A. Contractor must execute Work under this Specification in such a manner as to minimize impact to the daily operation of the rail, vehicular and pedestrian traffic.

B. The Contractor must barricade open excavations and post with warning lights those excavations occurring on property adjacent to or within public access areas and along the tracks in accordance with the SCRRRA Excavation Support Guidelines. Operate warning lights during hours from dusk to dawn each day and as otherwise required. Warning lights shall be located to avoid shining directly into Locomotive Engineer’s eyes in oncoming trains.
C. The Contractor must protect utilities, structures and facilities designated to be protected in place from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation and backfill operations.

D. The Work shall allow rainfall to drain freely at all times in accordance with project environmental requirements and permit conditions in accordance with Division 01 requirements.

1.06 ENVIRONMENTAL CONDITIONS

A. The Contractor must protect against erosion and uncontrolled run-off within and adjacent to right-of-way in accordance with the Project’s Storm Water Pollution Prevention Plan and the approved National Pollution Discharge Elimination System (NPDES) Permit in accordance with Division 01 requirements.

B. The Contractor must obtain all required permits for dewatering and legally dispose of water from dewatering operations.

1. Comply with requirements of permits and agencies having jurisdiction over the project site in accordance with Division 01 requirements.

C. Cleanliness, Sweeping and Dust Control shall be in accordance with Division 01 requirements.

D. Contractor must provide noise abatement as required by environmental permits or local agency requirements in accordance with Division 01 requirements.

1.07 REGULATORY REQUIREMENTS

A. Furnish required excavation Plans to jurisdictional authorities and obtain permits as required. Refer to Division 01.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Soil and rock materials for fill, backfill or subgrade preparation shall be in accordance with Section 31 20 00 or as specified by the Engineer in Responsible Charge.

B. Hot Mix Asphalt (HMA) pavement shall meet the requirements of Section 32 12 00.


E. Materials used in the excavation support system shall be new unless otherwise approved by SCRRA. Structural materials that compose the excavation support system shall meet the requirements for the applicable material type as listed, unless specified otherwise by the Engineer in Responsible Charge in the Contract Documents or approved Working Plans:

1. Structural steel: Section 03 21 00 for steel soldier piling and steel sheet piling and Section 34 80 51 for all other structural steel members.


3. Precast and prestressed concrete, including prestressing steel strand: Section 34 80 43.

4. Structural concrete: Section 03 31 00.

5. Reinforcing steel: Section 03 21 00.


PART 3 - EXECUTION

3.01 CONTRACTOR RESPONSIBILITIES

A. Prior to ordering materials or commencing any work:

1. Examine the Contract Documents, inspect the site, obtain all available Record Plans of existing structures and utilities and note all conditions and limitations that may influence excavation and temporary excavation support at the site.

2. Verify dimensions, elevations, extent of excavations and limits of excavation support required for construction and notify SCRRA of any discrepancies or omissions.

3. Assess the constructability of temporary excavation support systems specified in the Contract Documents and the applicability of any proposed method of support for the intended purpose.

B. Provide safe and stable excavations and maintain the integrity of excavations throughout the duration of construction.
C. Perform excavation and provide excavation support as required for construction in conformance with applicable laws, codes, ordinances, and regulations of federal, state and local authorities, including furnishing any required excavation Plans and obtaining any required permits.

3.02 ALTERNATE DESIGN

A. The Contractor will be allowed to propose and submit alternate methods, designs and details for excavations and temporary excavation support. Only alternates that comply with the SCRRA Excavation Support Guidelines and satisfy the contract requirements will be considered for acceptance. Acceptance of alternates will be at SCRRA’s sole discretion.

B. For alternate design submittal requirements, see 1.03 Submittals.

C. For alternate designs, the Contractor must retain a Contractor’s Design Engineer who will be the Engineer in Responsible Charge for the excavation and will act as the Contractor’s Engineer to verify construction in accordance with the design and approved working Plans and specifications prepared by said Engineer.

D. Review time by SCRRA as indicated in the SCRRA Excavation Support Guidelines must be considered in the construction schedule. Impacts to the construction schedule stemming from review time or rejection of modifications, substitutions or alternate designs shall not be cause for additional compensation for delay time or extension of contract time for performance.

E. The Contractor agrees, upon and at such a time that an alternate design is submitted to SCRRA, to compensate SCRRA for the full cost of reviewing the alternate design. This compensation shall include the initial review and any subsequent review of additional submittals or re-submittals to address previous SCRRA comments and must be paid regardless of the final disposition (acceptance or rejection) of the alternate design.

3.03 INSTALLATION

A. Preparation:

1. Initiate track monitoring program according to the approved Track Monitoring Plan.

2. Protect existing surface and subsurface features on-site and adjacent to site as required in Section 31 20 00 before excavating or installing temporary excavation support systems.

3. Install protective divider and/or fencing adjacent to active tracks as required in the SCRRA Excavation Support Guidelines.

4. Provide HMA track underlay for active tracks adjacent to proposed excavations as required in the SCRRA Excavation Support Guidelines.
   a. Install HMA in accordance with Section 32 12 00.
5. Perform site clearing in accordance with Section 31 11 00.

6. Perform demolition and removals in accordance with Section 31 11 50.

B. Operational Constraints:

1. Excavations and temporary excavation support systems shall be installed, maintained, removed and backfilled without interference to rail operations unless otherwise approved in advance by SCRRA.

2. Contractor operations will be constrained according to the approved SSWP and as needed to avoid interference with railroad operations.

3. Contractor must complete installation and removal of excavation support systems that require Work Windows within the approved time limits in the SSWP and as directed by the SCRRA Flagman or Employee-in-Charge.

4. Reference the SCRRA Excavation Support Guidelines for limitations to Contractor’s operations.

C. Excavations and Temporary Excavation Support:

1. Follow all requirements of the Contract Documents, approved working Plans, and SCRRA Excavation Support Guidelines for excavations and temporary excavation support.

2. Install temporary excavation support systems in a manner that maintains stability and integrity of the existing track, embankment and structures.

3. Perform excavation in accordance with Section 31 20 00 and in a manner that maintains stability and integrity of any temporary excavation support and the existing track, embankment and structures.

4. Temporary excavation support systems shall allow for permanent construction without movement or settlement of adjacent track, embankment or structures under all conditions and imposed loads for the duration of construction.

5. Dewater excavations as required and maintain water levels that prevent heave or piping.

6. Direct surface drainage away from existing tracks, structures, excavation support systems and open excavations, slope base of excavation away from support systems, and protect excavations and soil slopes from erosion.

7. Remove temporary excavation support systems in a manner that maintains stability and integrity of any remaining temporary excavation support and the existing track, embankment and structures.

8. Perform backfilling in accordance with Section 31 20 00.
9. Remove rubbish and spoil piles and return the area to a condition equal to or better than original and in accordance with Section 32 90 00.

D. Excavation Safety:

1. Perform excavation work in accordance with all applicable safety regulations including, but not limited to, SCRRRA, Federal OSHA, Cal/OSHA, FRA and CPUC. See the SCRRRA Excavation Support Guidelines for complete references.

2. Excavation safety shall be the responsibility of the Contractor.

3. Contractor must immediately comply with orders from SCRRRA to stop work or perform immediate backfilling of open excavations or other emergency remedial work when SCRRRA, at its sole discretion, determines that the safety of trains, passengers and SCRRRA employees may be in peril.

E. Schedule:

1. Include excavation and temporary excavation support installation, use and removal in the overall construction schedule and perform all work within the schedule presented in the approved construction plan. See Division 01.

3.04 FIELD QUALITY CONTROL/QUALITY ASSURANCE

A. Construction Verification:

1. The Contractor's Engineer must inspect the as-built excavation support system to verify that the system is constructed in accordance with the Contract Documents and working Plans that have been reviewed and accepted by SCRRRA.

   a. The number of site visits and the stage or stages of construction at which an inspection shall be performed will be determined as a condition of acceptance of the temporary shoring design to provide oversight by the Contractor's Engineer at critical construction stages.

2. The Contractor must prepare a letter and submit to SCRRRA confirming that the shoring system has been inspected and verified. The letter must be signed and sealed by the Contractor's Engineer who is a licensed Professional Engineer in the State of California.
a. Any field changes must be noted and the effect of those changes must be evaluated and reported by the Contractor's Engineer. Any deficiencies noted must be corrected by the Contractor. Deficiencies and corrections must be noted in the letter with verification of adequate correction by the Contractor’s Engineer.

B. Track Monitoring:

1. Monitor the excavation and the supported track in accordance with the approved Track Monitoring Plan, as described in the SCRRRA Excavation Support Guidelines, and as directed by SCRRRA.

2. Track monitoring data shall be delivered to SCRRRA in a format similar to that shown in the SCRRRA Excavation Support Guidelines no later than one working day after survey readings are taken.

3.05 ACCEPTANCE

A. Inspections:

1. Request, schedule and provide the means and access for inspection of the installed excavation support system and finished excavation by SCRRRA before proceeding with construction.

2. Once the excavation is no longer required for construction activities, request, schedule, and provide the means and access for inspection of the excavation support system by SCRRRA before proceeding with removal and backfilling operations.

B. Final Acceptance:

1. Apply for and obtain final acceptance from SCRRRA, with or without inspection at the sole discretion of SCRRRA, upon submittal of the final track monitoring data.

   a. Final track monitoring data shall be collected at the specified number of days following the completion of removal and backfilling operations per the approved Track Monitoring Plan.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. No separate measurement and payment will be made to the Contractor for Work of this Section. Work of this section shall include furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Measurement and Payment for excavation support will be incidental items to Section 31 20 00, Earthwork.
C. Submittals, working Plans, design modifications, structural detail changes, alternate design, review of alternate design, SSWP, inspections, verifications and track monitoring are incidental to Section 31 20 00 and no additional payment will be made therefore.

D. Any required testing and sacrificial test elements are incidental to Section 31 20 00 and no additional payment will be made therefore.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Work covered by this Section includes preparation, placement and compaction of all asphaltic concrete and slurry seal the existing pavement. It includes the prime coat, tack coat, base course and wearing course.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 01 - General Requirements.
2. Section 31 20 00 – Earthwork
3. Section 32 16 00 – Curbs, Gutters, and Sidewalks
4. Section 34 11 27 - Sub-Ballast and Aggregate Base.
5. Section 34 71 50 – Highway-Rail Grade Crossings

1.02 REFERENCES

A. Comply with the following Specifications, standards and recommended practices, except as otherwise indicated:


B. Caltrans: State of California Department of Transportation Standard Specifications, Section 39

C. ASTM: American Society for Testing and Materials

1. D2950, Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods

1.03 SUBMITTALS

A. Make all the following submittals in accordance with Section 01 33 00, Submittal Procedures.
1. Manufacturer’s installation instructions.

2. Asphalt design mix

3. Emulsion – Aggregate Slurry Design Mix.

4. Test reports from an independent laboratory for materials and mix designs or proof that mix designs and all Materials are currently approved for use as asphaltic concrete pavement by Caltrans.

5. Tests reports for field density tests performed after placement and compaction of each course of asphaltic concrete.

6. List of equipment to be used for the placing, spreading and compaction of the Hot Mix Asphalt Pavement. Only equipment approved by the Engineer shall be used.

1.04 DELIVERABLES

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

B. Submit copies of aggregate tests, penetrations of asphalt cement, and percentages by weight and number of pounds of each of the materials making up the batch.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Asphalts:

1. Asphalt binder to be mixed with aggregate shall be steam-refined paving asphalt of the grade designated in the special provisions.

   a. The asphalt binder shall be in conformance with the Caltrans Standard Specifications, Section 92 and SSPWC Section 203.

2. The amount of asphalt binder to be mixed with aggregate for asphalt concrete shall be in conformance with the requirements of the Caltrans Standard Specifications, Section 92.

3. Liquid asphalt for the prime coat shall be of the grade designated by the contract item or specified in the special provisions.

   a. The liquid asphalt shall be in conformance with the Caltrans Standard Specifications, Section 94 and SSPWC Section 203-2.
4. Asphalitic emulsion for the tack coat shall be of the grade designated by the Engineer.
   a. The asphalitic emulsion shall be in conformance with the Caltrans Standard Specifications, Section 94 and SSPWC Section 203-1.

5. Paving asphalt to be used as a binder for pavement reinforcing fabric shall be a steam-refined Pavement asphalt in conformance with the Caltrans Standard Specifications, Section 92.
   a. The Pavement asphalt shall be PG 70-10.

B. Aggregate:
   1. Aggregate shall be clean and free from decomposed materials, organic material and other deleterious substances.
      a. Coarse aggregate shall be material that is retained on the No. 4 sieve.
      b. Fine aggregate shall be material that is passing the No. 4 sieve.
      c. Supplemental fine aggregate is added fine material passing the No. 30 sieve, including, but not limited to, cement and stored fines from dust collectors.

   2. Aggregate grading shall be in conformance with the Caltrans Standard Specifications, Section 39.

   3. HMA pavement: Type A with ½” maximum, coarse aggregate gradation.

C. Prime Coat:
   1. Prime coat shall be an emulsified asphalt Type RS-2, conforming to Caltrans Standard Specifications, Section 94.

D. Tack Coat:
   1. Tack coat shall be a liquid asphalt Type SS-1, conforming to Caltrans Standard Specifications, Section 94.

E. Emulsion – Aggregate Slurry
   1. Emulsion – Aggregate slurry shall be of a slow-set or quick set type, conforming to SSPWC 20009, Section 203-5.2.

2.02 SOURCE QUALITY CONTROL

A. Take the following aggregate samples in the presence of the Engineer and, if requested, transport samples to AUTHORITY-hired testing laboratory. Samples will be used by the AUTHORITY-hired testing laboratory to test aggregate quality:
1. A 75-pound sample of representative aggregate retained on the #4 sieve and  

2. A 3-pound sample of the representative aggregate passing the #4 sieve for testing of aggregate quality.  

B. Provide Engineer access for sampling stockpiles, hot bin analyses, and other tests. 

PART 3 - EXECUTION 

3.01 GENERAL 

A. Subgrade, aggregate base, curbs, gutters and drains shall be approved by the Engineer before asphalt-Pavement operations are started.  

B. Emulsion – Aggregate slurry shall conform to the SSPWC 2009, Section 302-4.  

C. Mixing plants shall conform to the requirements of the Caltrans Standard Specifications 2010, Section 39-3.04 Mixing.  

D. Verify utility locations prior to driving stakes or pins.  

E. Construction procedures and requirements shall conform to SSPWC 2009, Section 302-5.  

F. Legally dispose of all waste material produced as a result of Contractor’s operations. All waste Materials shall be removed from the AUTHORITY’S property within 2 weeks of it being made waste. If necessary to protect the existing soils from contamination, install an impermeable barrier to protect the existing subgrade and runoff. 

3.02 FIELD QUALITY CONTROL 

A. Density of asphaltic concrete shall be measured using nuclear density methods in accordance with ASTM D 2950 at the time of placement.  

B. Density tests shall be performed by the Contractor's independent laboratory. The Engineer may also perform testing at random selected locations. Number of cores shall be one core per 500 square yards of bituminous pavements or two cores per shift, whichever is greater. Repair core holes promptly using the same mix that was cored; where cores are taken through both base course and surface course simultaneously, use surface course mix for repair work. Wherever deficient pavement is discovered, take such additional cores as directed.  

3.03 PREPARATION 

A. When placing HMA for access road paving, provide an aggregate base course in accordance with Section 34 11 27.
B. Schedule placement of asphalt pavement material when the precipitation probability, within 3 hours prior to the start of such operations, is less than 50 percent.

C. Laying of HMA shall not be permitted in wet weather.

D. Spreading of HMA shall not be permitted when the mixing temperature of HMA is below 250˚ F.

E. HMA shall only be placed when the atmospheric temperature is above 50˚ F.

F. When HMA is to be placed on an existing asphalt concrete, concrete, or brick surface, broom the existing surface clean prior to the application of the tack coat.

G. Repair holes and depressions in existing surfaces by removal to sound material and replace with an asphalt-aggregate patching material.

H. Compact patch to produce a tight surface conforming to the adjacent paving area.

I. Stabilize rocking Portland cement concrete slabs by undersealing or cracking and seating.

J. Fill wide joints and cracks with asphalt concrete/sand mix material and compact.

3.04 SPREADING

A. The depositing, distributing, and spreading of the HMA shall be accomplished in a single, continuous operation by means of a mechanical spreader or a grader.

1. When laying HMA for track underlay and the use of a mechanical spreader or a grader is impractical, the Contractor must submit a request for the use of alternate equipment to the Engineer for review.

B. The prime coat shall be applied at a rate of 0.25 gal/sq yd and shall be in conformance with the Caltrans Standard Specifications, Section 39.

C. The tack coat shall be applied in one application at a rate of 0.02 gal to 0.10 gal/sq yd of surface covered and shall be in conformance with the Caltrans Standard Specifications, Section 39.

D. Following application of the tack coat, the HMA shall be spread in conformance with the Caltrans Standard Specifications 2010, Section 39.

1. Successive lifts may be laid upon previously laid lifts as soon as the previous lift has cooled sufficiently to show no displacement under equipment or loaded material delivery trucks.

3.05 COMPACTION

A. Rollers:
1. Steel-wheeled, tandem type power driven rollers shall provide a pressure of not less than 225 lbs/in width of main roll.
   a. Rolls shall be smooth and without flat spots or other imperfections.

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

B. Rolling:

1. Proceed continuously at the following rates:
   a. For track underlay mixture, when spread by hand, not in excess of 400 sq yd/hr, per roller.
   b. For track underlay, when spread by machine, not in excess of 600 sq yd/hr, per roller.
   c. For HMA Pavement, when spread by hand, not in excess of 300 sq yd/hr, per roller.
   d. For HMA Pavement, when spread by machine, not in excess of 400 sq yd/hr, per roller.

2. Immediately after spreading, thoroughly compact by rolling with approved rollers continuously from commencement to final completion at a speed not exceeding three (3) miles per hours.

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

b. Smooth shallow ruts and ridges with tandem rollers immediately following the rubber-tired rolling.

4. First make final roll longitudinally with the paved surface and then diagonally or at right angles.

a. Continue until further compression results; the mixture has cooled; no marks show under the roller, and the surface is smooth and free from depressions, waves, bunches, and unevenness.

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

PART 4 - MEASUREMENT AND PAYMENT

3.01 MEASUREMENT

A. Prime Coat and Tack Coat will not be measured for payment. Costs associated with the prime or tack coats will be considered as incidental to the Hot Mix Asphalt Pavement.

B. Hot Mix Asphalt Pavement will be measured by the unit or fraction thereof installed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved Schedule of Values as derived from the Contract Drawings will be used as the basis for this measurement. Separate measurements will be made for each specified thickness of asphaltic concrete Material as included on the approved Schedule of Values.

C. The mass of the material will be determined as provided in Section 9-1.01, “Measurement of Quantities”, of the current Caltrans Standard Specifications.

4.02 PAYMENT

A. Hot Mix Asphalt Pavement constructed in accordance with the Contract Documents will be paid for at the Contract Unit Price of the specified type and thickness as included on the approved Schedule of Quantities and Prices. This price shall be full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals necessary for Hot Mix Asphalt Pavement described by the Contract Documents.
B. When there is no item for place Hot Mix Asphalt Pavement dike and the work is shown on the Plans, full compensation therefore, including and necessary excavation, backfill, and preparation of the area, shall be considered as included in the Contract Unit Price paid for the Hot Mix Asphalt Pavement.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. This Section consists of furnishing all labor, Materials and equipment necessary, and incidental to the manufacture, transport and placement of the curbs and gutters, related Material, and providing all associated items.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 01 - General Requirements.

2. Section 03 21 00 – Reinforcing Steel.

3. Section 03 31 00 – Structural Concrete.

1.02 REFERENCES

A. Comply with the following Specifications, standards and recommended practices, except as otherwise indicated:


3. CPUC: General Orders 26D and 118.

1.03 SUBMITTALS

A. Submit, under provisions of Division 01, the following information:

1. Compliance: Concrete mix and Materials, test reports, Manufacturer or Supplier’s certification that Materials delivered to site are in compliance with Specifications.

2. Samples: Sampling and testing for compliance with the contract provisions shall be in accordance with SSPWC 2012 Section 201-1.1.
3. Product Data: Submit to the Engineer the manufacturer's Standard Plans or catalog cuts, and Certificate of Conformance for joint filler or other Materials, which are specified to conform to publications referenced under "Products" in this Section.

PART 2 - PRODUCTS

2.01 PORTLAND CEMENT CONCRETE

A. Portland cement concrete for the construction of curbs and gutters shall conform to SSPWC 2012 Section 201-1.

B. The minimum 28-day compressive strength shall be 3250 psi (560-C-3250 – SSPWC) unless otherwise shown on the Plans.

2.02 REINFORCEMENT

A. All reinforcement for this portion of the Work shall conform to the provisions of Section 03 21 00. Reinforcing chairs shall be plastic or concrete.

2.03 JOINT FILLER

A. Premolded joint fillers shall conform to SSPWC 2012, Section 201-3.2.

PART 3 - EXECUTION

3.01 GENERAL

A. Establish and maintain required lines and elevations. Make gradual and smooth transitions to pavements.

3.02 ZERO FACE CURBS

A. Curb face shall be tapered to zero height within 10 feet of track centerline in order to comply with walkway requirements provision of CPUC General Order 118.

3.03 EXTRUDED PORTLAND CEMENT CONCRETE CURBS

A. Concrete curbs and gutters shall be constructed of Portland cement concrete of the class and other requirements specified in Section 303-5 of the SSPWC.

B. For curbs constructed on existing paving, refer to the Contract Documents for specific details and requirements for attaching curbs to existing paving.

C. Space joints in extruded curbs to match joints in adjacent paving. When the adjacent paving is not jointed, locate joints at angles, corners, points of curvature, and points of tangency at intervals of not more than 15 feet.
D. Joints shall be 1/8 inches minimum thickness and constructed to a minimum depth of 1 inch by scoring with a tool which will leave the corners rounded and destroy aggregate interlock to a depth of 1 inch.

E. Place expansion joints filler to full cross-section with 1/4 inches thick filler in the curb at abutting structures and at 100 foot intervals.

F. Cure the extruded concrete for not less than 72 hours by the methods specified in Section 34 80 41.

3.04 CAST-IN-PLACE CONCRETE CURB, AND COMBINED CURB AND GUTTER

A. Construction of cast-in-place curb, and combined curb and gutter shall meet the requirements of Section 03 31 00.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Concrete curbs, curb and gutters, sidewalks, and driveways will be measured by the unit or fraction thereof constructed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved Schedule of Values as derived from the plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Concrete curbs, curb and gutters, sidewalks, and driveways constructed in accordance with the Contract Documents will be paid for at the contract unit price as listed in the Schedule of Quantities. This price shall be full compensation for furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals necessary for concrete curbs, gutters and sidewalks described by the Contract Documents.

END OF SECTION
SECTION 32 17 23

PAVEMENT MARKINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Work involves furnishing all labor, materials and equipment necessary and incidental to applying pavement and platform striping, markings, markers, and painting of curbs.

1.02 REFERENCES

A. Comply with the following Specifications, standards and recommended practices, except as otherwise indicated:


1.03 SUBMITTALS

A. Submit the following in accordance with Division 01: Manufacturer's or supplier's certification that the materials delivered to the site are in compliance with the Specifications as specified in this Section.

1.04 QUALITY ASSURANCE

A. Pavement striping, markings, and markers shall be applied by workers with proven skills required to perform the work in accordance with the correct location, alignment, and dimensions of the striping and markings as shown in the Contract Plans or as modified by the Engineer.

B. At no additional cost to SCRRA, the Contractor shall repair or replace pavement markings, which fail to present a uniform appearance and those, which are marred and damaged by traffic and by other causes.
C. Until accepted by the Engineer, the Contractor must be responsible for the maintenance of all pavement striping, markings, and markers until the roadway is open to vehicular traffic.

D. All pavement striping and marking for roadways, whether temporary or permanent shall be completed before the roadway is opened for vehicular traffic.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Paint for traffic striping and markings shall comply with Caltrans Standard Specifications 2010 Section 84-3. Type of paint shall either be Fast Dry or Rapid Dry solvent borne. Thermoplastic traffic stripes and pavement markings shall comply with Caltrans Standard Specifications Section 84-2. Markers shall comply with Standard Specifications Section 85-1.02.

2.02 COLOR

A. Color for roadways shall be Caltrans Standard Specifications “white” and “yellow” unless otherwise indicated in the plans.

B. Painting of curbs shall use the color indicated in the Contract Plans.

PART 3 - EXECUTION

3.01 GENERAL

A. Apply paint by using a striping machine, except for special areas and markings, which are inaccessible or not adaptable to machine application, in which case hand application will be permitted with approved masking or stencil use.

B. The striping machine shall be an approved spray-type marking machine capable of producing the specified dimensions of the markings and stripings with clear-cut edges and uniform smooth film thickness.

C. The minimum wet film thickness of the paint shall be 15 mils or in accordance with the manufacturer’s recommendation and approved by the Engineer.

D. Application of the paint shall be made only on a dry and clean surface free from grease, oils, dirt, curing compound or any other foreign matter, when the weather is not windy and humid, and the ambient air temperature is not less than 40 DegF. Contractor must not apply paint to uncured concrete.
E. Placement of pavement markers shall comply with Caltrans Standard Specifications Section 85-1.03.

F. Contractor must clean up all overspray with approved Materials and leave a clean and complete project.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Pavement Markings will be measured by the unit or fraction thereof furnished and placed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved Schedule of Values as derived from the plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Pavement Markings completed in accordance with the Contract Documents will be paid for at the contract unit price, as listed in the Schedule of Quantities and Pricing. This price shall be full compensation for furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals necessary for Pavement Markings described by the Contract Documents.

END OF SECTION
SECTION 32 31 13

CHAIN LINK FENCING AND GATES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Chain link fencing and gates including the chain-link fence fabric and posts, concrete for post bases, rails, ties, bands, bars, rods and other fittings and hardware designed to support the fabric in a vertical, taut position.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 01 - General Requirements.
2. Section 03 31 00 - Structural Concrete.

1.02 REFERENCES

A. ASTM International (ASTM):

4. A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
5. A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing


B. American Welding Society (AWS).

C. Chain Link Manufacturer's Institute for "Galvanized Steel Chain Link Fence Fabric and Accessories."

D. SCRRRA Engineering Standards ES5106, Right of Way Fencing, Chain Link Fence.

1.03 DEFINITIONS

A. See ASTM F552.

B. NPS: Nominal pipe size, in inches.

C. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

1.04 SUBMITTALS

A. Shop Drawings:
   1. Submittals shall be made in accordance with provisions contained in Division 01.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   3. Scaled plan layout showing spacing of components, accessories, fittings, and post anchorage.
   4. Details of fence materials, foundations, anchorage details and gate details.
   5. Source quality control test results.
1.05 QUALITY ASSURANCE

A. Qualifications:

1. Installer shall have a minimum two (2) years experience installing similar fencing.

2. Utilize only AWS certified welders.

B. Construct fence within reasonable close conformity to lines and grades shown on the Plans and at the locations as directed by the Engineer.

PART 2 - PRODUCTS

2.01 COMPONENTS

A. Components for Chain Link Fencing shall conform to SCERRA Engineering Standards ES5106, Right of Way Fencing, Chain Link Fence and these Specifications.

B. Chain Link Fabric:

1. Fabric type:
   a. ASTM A392 zinc-coated steel:
      1) Coated before weaving, 2.0 oz/sf.

2. Wire gage shall be 11-gage for fences 6 feet-0 inches and less and 9-gage for fences over 6 feet-0 inches in accordance with the Project Plans or as determined by the Engineer based on field conditions in accordance with SCERRA Engineering Standards ES5106.

3. Mesh size shall be 1 inch.

4. Selvage treatment:
   a. Top: Knuckled.
   b. Bottom: Knuckled.

C. Concrete:

1. Minimum cement content shall be 560 lbs/cu. yd.

2. Minimum 28-day compressive strength shall be 3,250 psi.

3. Concrete shall be supplied and tested in accordance with Section 03 31 00.
D. Line Post:
   1. ASTM F1083 pipe:
      a. Table 1, Schedule 40, regular grade, in sizes as specified on SCRRA Engineering Standards ES5106.

E. Corner or Terminal Posts:
   1. ASTM F1083 pipe:
      a. Table 1, Schedule 40, regular grade, in sizes as specified on SCRRA Engineering Standards ES5106.

F. Brace and Rails:
   1. ASTM F1083 pipe:
      a. Table 1, Schedule 40, regular grade, in sizes as specified on SCRRA Engineering Standards ES5106.

G. Tension Wire and bars:
   1. Top and bottom of fabric:
      a. ASTM A824, galvanized steel, Class 3.
      b. Minimum 7-gage galvanized coil spring steel wire.
   2. Tension bars used in fastening fabric to end and corner posts and gate frames:
      a. ASTM A500 or A501, minimum 3/16 inches x 3/4 inches galvanized high carbon steel bars.

H. Fence Fittings (Post and Line Caps, Rail and Brace Ends, Sleeves-Top Rail, Tie Wires and Clips, Tension and Brace Bands, Tension Bars, Truss Rods):
   1. ASTM F626.
   2. Tie wires shall not be smaller than 11 gage galvanized steel, 6 gage aluminum wire or approved noncorrosive bands.
   3. Truss or tension rods shall be adjustable 3/8 inches dia. galvanized steel rod.
      a. Adjustable galvanized turnbuckles or other suitable tightening devices shall be provided as necessary.
I. Security Gate:

1. ASTM F900.
   a. Gate posts in sizes as shown in SCRRA Engineering Standards ES5106.


3. Hardware:
   a. Galvanized per ASTM A153.
   b. Hinges to permit gate opening as shown in the plans.

4. Hang gates on at least two (2) steel or malleable iron hinges not less than 3-inches in width, designed to clamp to the gate post and permit the gate to be swung as indicated in the plans. The bottom hinge shall have a socket to take the ball end of the gate frame.

5. Gates shall be provided with a combination steel or malleable iron catch and locking attachment system of approved design which will not rotate around the latch post.

6. Stops to hold gates open and a center rest with catch shall be provided where required.

J. Security Extension:

1. Extension arms for barbed wire shall be a type that can be attached to the tops of posts and carry three wire at approximately 5-1/2 inches centers.

2. Barbed wire shall be four-point pattern, composed of:
   a. Two strand, 12-1/2 gage galvanized steel wire.
   b. Barbs spaced at 5 inches centers.
   c. Conform to ASTM A121.

2.02 SOURCE QUALITY CONTROL

A. Test related fence construction materials to meet the following standards:

1. Posts and rails:
   a. ASTM F1043, Heavy Industrial.

2. Results of tests to be submitted with material certification submittals.
PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with:
   1. Manufacturer's instructions.
   2. Lines and grades shown on approved Plans.
   3. In accordance with ASTM F567.
   4. In accordance with SCRRA Engineering Standards ES5106.

B. In case of conflict between four above mentioned installation procedures, SCRRA Engineering Standards ES5106 takes precedence; use in lieu of conflicting portions.

C. Work shall be performed by workmen who are thoroughly trained and experienced in the skills required to install the products of this Section.

D. Do not start fence installation before final grading is complete and finish elevations are established.

E. Drill holes for posts in firm, undisturbed or compacted soil.

F. Posts shall be placed in a vertical position, except as directed by the Engineer where they may be set perpendicular to the ground surface.

G. Posts shall be set in concrete footings conforming to the details shown on the plans or SCRRA Engineering Standards ES5106 and crowned at the top to shed water.

H. Place fence with bottom edge of fabric at maximum clearance above grade, as shown on Plans.
   1. Correct minor irregularities in earth to maintain maximum clearance.

I. Space line posts at equal intervals not exceeding 10 feet on center.

J. Provide post braces for each gate, corner, pull and terminal post and first adjacent line post.

K. Install tension bars full height of fabric.
   1. Rails: Fit rails with expansion couplings of outside sleeve type when called for in plans.
   2. Install rails continuous for outside sleeve type for full length of fence
3. Provide expansion couplings in top rails at not more than 20 feet intervals.

4. Anchor top rails to main posts with appropriate wrought or malleable fittings.

L. Install bracing assemblies at all end and gate posts, as well as side, corner, and pull posts.
   1. Locate compression members at mid-height of fabric.
   2. Extend diagonal tension members from compression members to bases of posts.
   3. Install so that posts are plumb when under correct tension.

M. Pull fabric taut and secure to posts and rails.
   1. Secure so that fabric remains in tension after pulling force is released.
   2. Secure to posts at not over 15 inches o.c., and to rails at not over 24-inches o.c., and to tension wire at not over 24-inches o.c.
   3. Use U-shaped wire conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least two (2) full turns.
   4. Bend ends of wire to minimize hazards to persons or clothing.
   5. Fabric shall be placed on the outside of poles away from the track or as directed by the Engineer.

N. Install post top at each post.

O. Gates:
   1. Construct with fittings or by welding.
   2. Provide rigid, weatherproof joints.
   3. Assure right, non-sagging, non-twisting gate.
   4. Coat welds with rust preventive paint, color to match pipe.
PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Chain Link Fencing will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Chain Link Gates will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

C. Quantities of gates will be determined from actual count. When more than one gate is placed in an opening, each single unit placed will be counted as a gate. A gate unit complete shall include one gate with necessary fittings, hardware and gate posts with braces.

D. Chain Link Fencing and gates shall consist of a fabric, including posts, horizontal members, post anchorages, stretcher bars, tension wires and other required hardware and fittings, as shown on the Contract Documents.

4.02 PAYMENT

A. Chain Link Fencing furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Chain Link Gates furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

C. Full compensation for furnishing and installing connections on Fencing and Gates, drilling anchor bolt holes and bolts shall be considered as included in the prices and no additional compensation will be allowed.

D. Full compensation for furnishing and installing fabric, posts, post tops, tension wires, post clips, wire ties and hog rings shall be considered as included in the prices and no additional compensation will be allowed.
E. Full compensation for clearing the line of the fence and disposing of the material, excavating high points in the existing ground, excavating and backfilling holes, disposing of surplus excavated material, and furnishing and placing concrete footings and connecting new fences to structures and existing cross fencing, and constructing temporary fences for protection of stock, shall be considered as included as listed on the Schedule of Quantities and Prices.

END OF SECTION
PART 1 – GENERAL

1.01 DESCRIPTION

A. Work involves furnishing all materials, labor and equipment necessary and incidental to the installation of wire mesh fence at the locations shown on the Contract Plans.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 – General Requirements
   2. Section 01 33 00 – Submittal Procedures
   3. Section 03 31 00 – Structural Concrete

1.02 REFERENCES

A. Comply with all local, State and Federal codes, regulations, Specifications, standards and recommended practices.

B. ASTM: American Society for Testing and Materials
   1. A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
   3. A185 Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
   4. A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
   5. A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
   8. D1654 Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
11. F2408 Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets

C. SSPWC: Standard Specifications for Public Works Construction 2012 Section 304


1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00, Submittal Procedures:

1. Compliance: Manufacturer's or supplier's certification that the materials delivered to the site are in compliance with the Specification.

2. Product data in form of manufacturer's technical data, and installation instructions for the fence.


1.04 QUALITY ASSURANCE

A. Work shall be performed by workmen who are thoroughly trained and experienced in the skills required to install the products of this Section.

B. Construct fence to lines and grades shown on the Contract Plans and at other locations as directed by Engineer.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Fence: SuperMeshG Fencing manufactured by Secure Technology, Inc. of 23016 Del Lago Drive, Suite A, Laguna Hills, CA 92653. Telephone 949-707-4270. Fence materials to be galvanized. An equal product may be used provided it is approved by the Engineer.

B. Fence: Fencing manufactured by Betafence USA, Ennis, Texas 75118. Telephone 888-650-4766. Fence materials to be galvanized. An equal product may be used provided it is approved by the Engineer.

C. Concrete: Class 500-C-2500 per SSPWC Section 201
PART 3 – EXECUTION

A. Unless otherwise specified or directed construct fence in accordance with materials and methods to conform to the Contract Plans and installation instructions provided by the supplier.

B. Fence top extension shall face away from the track.

C. Posts shall be installed at 10 feet intervals in accordance with SSPWC Section 304-3 for installation of posts.

D. Galvanizing damaged during installation shall be repaired in accordance with SSPWC Section 210-3.5, Repair of Damaged Zinc Coatings.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Welded Wire Fencing will be measured by the unit or fraction thereof furnished and installed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved Schedule of Values as derived from the Plans will be used as the basis for this measurement.

B. Welded Wire Gates will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

C. Quantities of gates will be determined from actual count. When more than one gate is placed in an opening, each single unit placed will be counted as a gate. A gate unit complete shall include one gate with necessary fittings, hardware and gate posts with braces.

D. Welded Wire Fencing and gates shall consist of a fabric, including posts, horizontal members, post anchorages, stretcher bars, tension wires and other required hardware and fittings, as shown on the Contract Documents.

4.01 PAYMENT

A. Welded Wire Fencing and Gates constructed in accordance with the Contract Documents will be paid for at the Contract Unit Price as included on the approved Schedule of Quantities and Prices. This price shall be full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals necessary for Welded Wire Fencing and Gates described by the Contract Documents.
B. Gates installed in accordance with the Contract Documents will be paid for by actual count at the Contract Unit Price as listed on the Schedule of Quantities and Prices.

C. Full compensation for furnishing and installing connections on Welded Wire Fencing and Gates, drilling anchor bolt holes and bolts shall be considered as included in the prices and no additional compensation will be allowed.

D. Full compensation for furnishing and installing fabric, posts, post tops, tension wires, post clips, shall be considered as included in the prices and no additional compensation will be allowed.

E. Full compensation for clearing the line of the fence and disposing of the material, excavating high points in the existing ground, excavating and backfilling holes, disposing of surplus excavated material, and furnishing and placing concrete footings and connecting new fences to structures and existing cross fencing, and constructing temporary fences for protection of stock, shall be considered as included as listed on the Schedule of Quantities and Prices.

END OF SECTION
SECTION 32 31 19
TUBULAR STEEL FENCING AND GATES

PART 1 – GENERAL

1.01 DESCRIPTION

A. This Work involves furnishing all materials, labor and equipment necessary and incidental to the installation of tubular steel fencing, inter-track fence, edge fencing, and gates, including station platform center and edge, as shown on the Contract Plans.

B. Coordinate the work of this Section with all other Sections of this Specification and, in particular:

1. Division 01 – General Requirements
2. Section 03 31 00 – Structural Concrete

1.02 REFERENCES

A. Comply with all local, State and Federal codes, regulations, specifications, standards and recommended practices.

B. ASTM: American Society for Testing and Materials

1. A36 Specification for Carbon Structural Steel
3. A153 Standard Specification for Zinc Coating (Hot-dip) on Iron and Steel Hardware
4. A525 Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process
5. A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

1.03 **SUBMITTALS**

A. Submit Shop Drawings showing plan layout, grid, spacing of components, accessories, fittings and hardware.

B. Submit manufacturer’s product data.

C. Submit manufacturer’s installation instructions.

D. Submit manufacturer’s color palette to the Engineer for approval.

1.04 **QUALITY ASSURANCE**

A. Obtain the services of fencing manufacturer’s field representative to provide the following services:
   
   1. Supervise the entire installation of the fence.
   
   2. Render advice and assistance on the installation of the fence panels, fasteners, and bracing.

B. Construct fence to lines and grades shown on the Contract Plans and at other locations as directed by Engineer.

1.05 **DELIVERABLES**

A. Submit manufacturer’s certificates of compliance for fence materials.

B. Qualifications: Submit name, business address and telephone number of manufacturer’s field representative. Include certification by the manufacturer that proposed field representative is qualified to provide specified services.

C. Furnish certificate of inspection stating that the material has been sampled, tested and inspected per ASTM A525.

D. Certification of Installation: Subject affidavit by the manufacturer’s field representative certifying that the installation of the fence meets the Contract requirements.

**PART 2 – PRODUCTS**

2.01 **FENCE AND GATES**

A. Pickets and rings: Pickets and rings shall be galvanized, 1-inch solid square steel tubular members conforming to ASTM A787, 45,000 psi yield strength, and G90 zinc coating. Picket spacing shall be 4 inches maximum center to center.

   1. Rings occur at center fence.
B. Panel height: Finished fence height shall be 6 feet at center fence and 3’-2” feet at platform edge fence. Panel width shall be as per SCRRA Engineering Standards ES5102 and 5104.

C. Posts:
   1. Galvanized, square steel tubular members conforming to ASTM A653, 50,000 psi yield strength and G90 zinc coating.
   2. Posts shall be 2-1/2 inches x 2-1/2 inches minimum, with a wall thickness of 12 gauge.
   3. Base Plates and Miscellaneous Hardware for Center Fence: ASTM A36/A36M.

D. Horizontal Rails:
   1. Galvanized, square steel tubular members conforming to ASTM A653, 50,000 psi yield strength and G90 zinc coating.
   2. Rails shall be 1 inch by 2 inches minimum, with a wall thickness of 1/8 inch.
   3. Attach rails to posts with tamper resistant fasteners.

E. Gate Hardware: Hinges, latches, drop rods, as needed, shall be hot dipped galvanized steel in accordance with ASTM A153 and sized to assure proper gate operation.

2.02 CONCRETE

A. Concrete: Concrete shall conform to Section 03 31 00, Structural Concrete.

2.03 SHOP FINISHES

A. Zinc: Hot dipped galvanize pickets, rings, rails, and posts after fabrication in accordance with ASTM A123.

B. Powder Coat: Powder coat all parts of fence including hardware after galvanizing and in accordance with coating manufacturer’s instructions. Powder coat: O’Brien TGIC-Polyster or approved equal. Color: Black.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Concrete Footings: Drill or dig holes for post footings in firm, undisturbed or compacted soil. Size footings in accordance with Contract Plans or approved Shop Drawings. Trowel tops of footings and slope or dome to direct water away from posts. Slope, do not dome, in pedestrian paving.
B. Posts: Spaced at 10 feet or less on center and set in concrete footings, plumbed vertical. Post depth as specified on the Contract Plans. Space posts at lesser distance between centers to compensate for terrain variation such as sharp variations in incline or decline. Any high points that interfere with placing the fence shall be excavated to provide the clearance shown on the Contract Plans.

C. Field Joints: Field joints shall be kept to a minimum and concealed to the greatest extent possible. Field joints shall be strong, rigid, watertight and flush with hairline fit. Ease sharp corners.

D. Adjust fence for uninterrupted visual continuity and tight, non-rattling connections.

3.02 REPAIR

A. Welded and abraded areas of galvanized surfaces shall be wire brushed and repaired with two (2) coats of cold galvanized compound.

B. Repair abraded or damaged powder-coated per manufacturer's instructions and to the satisfaction of the Engineer.

A. Unless otherwise specified or directed construct fence in accordance with materials and methods to conform to the Contract Plans and installation instructions provided by the supplier.

B. Fence top extension shall face away from the track.

C. Posts shall be installed at 10 feet intervals in accordance with SSPWC 2009 Section 304-3 for installation of posts.

D. Galvanizing damaged during installation shall be repaired in accordance with SSPWC 2009 Section 210-3.5, Repair of Damaged Zinc Coatings.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Tubular Steel Fencing will be measured by the unit or fraction thereof Installed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved Schedule of Values as derived from the plans will be used as the basis for this measurement.

B. Tubular Steel Gates will be measured by the unit or fraction thereof Installed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved Schedule of Values as derived from the plans will be used as the basis for this measurement.

C. Quantities of gates will be determined from actual count. When more than one gate is placed in an opening, each single unit placed will be counted as a gate. A
gate unit complete shall include one gate with necessary fittings, hardware and
gate posts with braces.

D. Tubular Steel Fencing and Gates shall consist of a pickets and rings, including
posts, horizontal members, post anchorages, rails and other required hardware
and fittings, as shown on the Contract Documents.

4.01 PAYMENT

A. Tubular Steel Fencing constructed in accordance with the Contract Documents
will be paid for at the Contract Unit Price as included on the approved Schedule
of Quantities and Prices. This price shall be full compensation for furnishing all
labor, Materials, tools, equipment, supplies, supervision, and incidentals
necessary for Tubular Steel Fencing described by the Contract Documents.

B. Gates installed in accordance with the Contract Documents will be paid for by
actual count at the Contract Unit Price as listed on the Schedule of Quantities
and Prices.

C. Full compensation for furnishing and installing connections on Tubular Steel
Fencing and Gates, drilling anchor bolt holes and bolts shall be considered as
included in the prices and no additional compensation will be allowed.

D. Full compensation for furnishing and installing pickets and rings, posts, and post
tops, shall be considered as included in the prices and no additional
compensation will be allowed.

E. Full compensation for clearing the line of the fence and disposing of the material,
excavating high points in the existing ground, excavating and backfilling holes,
disposing of surplus excavated material, and furnishing and placing concrete
footings and connecting new fences to structures and existing cross fencing, and
constructing temporary fences for protection of stock, shall be considered as
included as listed on the Schedule of Quantities and Prices.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Furnish and install a complete microprocessor based vehicular swing gate or slide gate operator system, with a solid-state board to control all functions of the gate operator, as described herein and shown on the plans. Include all necessary control boards, power supplies, loop detectors, connectors, and accessories for a complete operational system.

1.02 CONTRACT DOCUMENTS

A. All equipment and work specified in this section shall comply with all the General Conditions of the specifications, contract documents, and drawings as indicated.

1.03 RELATED WORK

A. Gate operator systems contractor shall coordinate all work with other contractors and trades where necessary.

B. All necessary conduit, raceways and pull boxes shall be installed by the electrical contractor.

C. Installation of the vehicular gate operator system shall be coordinated with the installation of other applicable systems and components (e.g. access control system, fire department key access box, etc.)

1.04 QUALITY ASSURANCE

A. Installation shall comply with all applicable codes.

B. All equipment shall be new, in current production, and the standard products of a manufacturer of vehicular gate operator equipment.

C. Manufacturer shall guarantee availability of parts, for a minimum of seven (7) years from date of shipment.

D. If required, manufacturer shall be able to demonstrate features, functions and operating characteristics to the Owner.

E. System shall be installed by a factory authorized contractor, with technicians specifically trained in this system.

F. On-site maintenance and repair service shall be available locally and within four (4) hours of notification for emergency condition.
1.05 REFERENCE STANDARDS


B. Vehicular Swing Gate Operator shall be tested for compliance to UL 325 and UL 991 and shall be LISTED by a Nationally Recognized Testing Laboratory (NRTL).

C. Vehicular swing gate fabrication, construction and installation shall conform to ASTM F2200; Standard Specification for Automated Vehicular Gate Construction.

1.06 SUBMITTALS

A. Provisions: Comply with Section 01 33 00 SUBMITTALS.

B. Equipment list, data sheet(s), system description, block diagrams on equipment to be furnished and electrical wiring diagrams for installation.

C. All data necessary to evaluate design, quality and configuration of proposed equipment and system(s).

1.07 WARRANTY

A. Products shall include a factory warranty that equipment is free from defects in design, material, manufacturing and operation. Factory warranty period shall be for five (5) years parts and workmanship; 60-months from date of shipment.

B. Manufacturer shall not be responsible for improper use, handling, or installation of the product.

C. Installing contractor shall guarantee the equipment, wire and installation for 12-months from date of acceptance.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. For vehicular swing gate operator, equipment and materials shall be as manufactured by Doorking, Inc., Model 6550, or approved equivalent.

B. For vehicular slide gate operator, equipment and materials shall be as manufactured by Doorking, Inc., Model 9150 (1 HP), or approved equivalent.

C. Substitutions must meet requirements of Prior Approval, as outlined in the contract documents. Substitutions that meet Prior Approval requirements must be listed as alternates by addendum, and shall be shown separately on the bid forms. Consideration will be based on ability to comply with all aspects of the specifications, the desired functional operation, quality, reliability, design, size, and
appearance of the equipment, and the support capabilities of the manufacturer.

2.02 VEHICULAR SWING GATE OPERATOR

A. Swing Gate Operator:

1. The swing gate operator shall use a microprocessor based solid-state control board that controls all functions of the swing gate operator. Operator shall be rated minimum for commercial and industrial applications.

2. Primary reduction system shall be provided by single cog belt drive train and 60:1 worm gear reduction running in a continuous oil bath.

3. Operator shall employ magnetic sensing to set open and close limit adjustment. Mechanical type limit switches shall not be allowed.

4. Operator system shall be capable of bi-parting (dual) gate operation without the need of any add-on circuit boards. Primary operator shall control all functions of both gate operators. Secondary operator shall not require a control board.

5. Operator shall be designed for either left or right hand mount and shall be designed for pad mounting.

6. Operator frame shall welded steel anodized black. Control box shall be constructed from 16-gauge G90 galvanized steel, painted black, to avoid rusting. Operator cover shall use polyethylene finished in charcoal gray, suede texture.

7. Operator shall have three 115 VAC convenience outlets available for accessory transformer power and shall have a built-in lockable power disconnect and reset switch.

B. Control Circuit:

1. Control board shall have connections for optional board to record operator cycles (x100), input errors, loop detector errors, obstruction hits, and power up events. Record shall be time and date stamped.

2. Control board shall be capable of controlling two (2) vehicular swing gate operators in a true bi-parting gate operation.

3. Control board shall have a gate overlap feature for bi-parting gate operation.

4. Control board shall have ports for plug in of vehicular loop detectors.

5. Control board shall have separate inputs for external contact and non-contact entrapment protection devices.

6. Control board functions will be user programmable by DIP-switches located on the control board.
7. A dry set of relay contacts shall be available for external use, and have four programmable functions.

8. The control board shall have terminals for direct connection of a magnetic lock.

C. Manual Operation

1. Operator shall be equipped with a built-in manual release mechanism. Release mechanism shall be lockable and an integral part of the operator.

D. Primary Electronic Reverse

1. The vehicular gate operator shall be equipped with an inherent electronic obstruction sensing system. The electronic sensing system shall automatically cause the gate operator to stop and reverse if an obstruction is sensed during the open or close cycle.

E. Secondary Entrapment Prevention

1. Non-contact sensors, or contact sensors, or combination thereof, shall be utilized to prevent persons from becoming entrapped in the gate system.

2. Warning signs shall be installed in accordance with manufacturer's installation instructions and UL 325 guidelines.

F. Technical Features

1. 2000-lb. maximum gate weight

2. 25-ft maximum gate length

3. Motor: 1 HP, Continuous duty AC motor

4. Power: 115 VAC, 60 Hz, 9.7A

5. UL Class of Operation: I, II, III, IV

6. Single cog belt driving a 60:1 worm gear reduction system running in a continuous oil bath

7. Magnetic limit adjustment system

8. Solid-state control circuit and motor control

9. Gate swing time (from 0° to 90°) of approximately 12-17 seconds

10. Minimum of three (3) 115 VAC convenience outlets

11. Operating temperature: 10°F to 115°F

12. Auto close timer of no more than 23 seconds
13. Dimensions: No greater than 39 inches high, 21 inches wide, 30 inches deep

2.03 VEHICULAR SLIDE GATE OPERATOR

A. Slide Gate Operator:

1. The slide gate operator shall use a microprocessor based solid-state control board that controls all functions of the slide gate operator. Operator shall be rated minimum for continuous duty in commercial and industrial applications.

2. Primary reduction system shall employ an adjustable clutch and power transfer shall be provided by single cog belt drive train.

3. Operator shall employ magnetic sensing to set open and close limit adjustment. Mechanical type limit switches shall not be allowed.

4. Operator shall automatically set both open and close limit adjustments upon power-up and activation in the open direction. Operator shall automatically sense for any gate coasting to insure true limit settings.

5. Pulling medium shall provide a positive mechanical connection to the gate system. Friction driven rail type pulling mediums shall not be allowed. Roller chain pulling medium shall be minimum size #40.

6. A positive dead bolt shall activate only when the gate is forced open, to reduce solenoid lock wear and failure.

7. Operator shall be capable of being mounted at the front, center or rear of the gate system, shall be designed for either left or right hand mount and shall be designed for pad or post mounting.

8. Operator frame shall use 12-gauge G90 galvanized steel to avoid rusting and shall be painted charcoal gray.

9. Operator shall have two 115 VAC convenience outlets available for accessory transformer power and shall have a built-in lockable power disconnect and reset switch.

B. Control Circuit:

1. Control board shall have connections for optional board to record operator cycles (x100), input errors, loop detector errors, obstruction hits, and power up events. Record shall be time and date stamped.

2. Control board shall allow a stop or a stop and reverse function (settable) from a safety related input.

3. Control board shall have ports for plug in of vehicular loop detectors.
4. A dry set of relay contacts shall be available for external use, and shall have four programmable functions.

5. A special input shall allow the gate to be partially opened.

6. A timer override function shall cause an opening gate to stop and then reverse direction when the reverse loop(s) or reverse input is clear even if the gate has not reached the full open position, to help reduce tailgating.

7. Control board shall have separate inputs for external contact and non-contact entrapment protection devices.

8. Functions will be user programmable by DIP-switches located on the control board.

C. Fail-Safe Operation

1. To prioritize safety over security, operator shall assume a fail-safe mode in the event of a power loss or if an entrapment is sensed (entrapment alarm activated).
   a. Operator shall revert to a fail-safe mode allowing the gate to be pushed open without any special knowledge or use of any special cranks, keys or other devices.

D. Primary Electronic Reverse

1. The vehicular gate operator shall be equipped with an inherent electronic obstruction sensing system. The electronic sensing system shall automatically cause the gate operator to stop and reverse if an obstruction is sensed during the open or close cycle.

2. For enhanced safety, the control circuit shall check the obstruction sensing system circuit prior to the start of each cycle of operation. Should the control circuit detect a fault in the obstruction sensing system, the motor shall not be allowed to start.

E. Secondary Entrapment Prevention

1. Non-contact sensors, or contact sensors, or combination thereof, shall be utilized to prevent persons from becoming entrapped in the gate system.

2. Warning signs shall be installed in accordance with manufacturer's installation instructions and UL 325 guidelines.

F. Technical Features

1. 1500-lb maximum gate weight

2. 45-ft maximum gate length

3. Motor: 1 HP, continuous duty AC motor
4. Power: 115 VAC, 60 Hz, 9.7A
5. Single cog belt drive train with adjustable clutch
6. Automatic limit / coast magnetic adjustment system
7. Solid-state control circuit and motor control
8. Partial open limit feature
9. Anti-Tailgate feature
10. UL Class of Operation: I, II, III, IV
11. #40 roller chain.
12. Minimum gate speed of 10 in/sec
13. Minimum of two (2) 115 VAC convenience outlets
14. Operating temperature: 10°F to 140°F
15. Auto close timer of no more than 23 seconds
16. Dimensions: No greater than 25 inches high, 16 inches wide, 17 inches deep

PART 3 - EXECUTION

3.01 INSTALLATION

A. It is preferred, but not required, that this product be installed by a qualified technician who is certified by the Institute of Door Dealer Education and Accreditation (IDEA) as a Certified Automatic Gate Operator Installer (CAGOI).

B. Swing gate operator shall only be pad mounted, as required. Slide gate operator shall either be pad or post mounted, as required.

1. Pad mount: Mounted directly to a concrete pad, firmly secured, plumb and level.

2. Post mount: Mounting posts shall be welded to base plate and mounted in concrete, firmly secured, plumb and level.

C. Wiring shall be uniform and in accordance with national electric codes and manufacturer’s instructions.

D. All splices shall be in easily accessible junction boxes or on terminal boards.

E. All cable runs in all junction boxes shall be tagged and identified.
F. Coordinate all work with other affected trades and contractors.

3.02 SYSTEM Initializing AND PROGRAMMING

A. System shall be turned on and adjustment made to meet requirements of specifications and on-site conditions.

B. System shall function as specified.

3.03 SYSTEM TEST PROCEDURES

A. System shall be completely tested to assure that all components and accessories are hooked-up and in working order.

B. System shall be pre-tested by contractor and certified to function in accordance with plans and specifications.

C. System shall be tested in presence of owner's representative.

3.04 OWNER INSTRUCTIONS

A. Installation contractor shall conduct up to (1) hour of instruction in use and operation of the system to designated owner representatives, within (30) days of acceptance.

B. Installation contractor shall conduct up to (1) hour of technical training, in troubleshooting and service of the system, to designated owner representatives within (90) days of system acceptance.

3.05 MANUALS AND DRAWINGS

A. Contractor shall provide owner with (2) copies of standard factory prepared operation, installation and maintenance manuals. Manuals shall include typical wiring diagrams.

B. Contractor shall provide owner with (2) copies of any risers, layouts, and special wiring diagrams showing any changes to standard drawings, if required on project.

3.06 MAINTENANCE

A. The manufacturer recommends periodic maintenance at three month intervals as described in the installation and maintenance manual.

B. External reversing devices should be checked at least once a month.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Automated vehicular swing gate operator system will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract
Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Swing Gates will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

C. Automated vehicular swing gate operator system shall consist of automatic exit gate detectors, safety/reverse loop detectors, swing gate operators, underground conduits and cables, power conduit and line, communications conduit and line, fire department key access box and other required hardware and fittings, as shown on the Contract Documents.

D. Quantities of swing gates will be determined from actual count. When more than one swing gate is placed in an opening, each single unit placed will be counted as a swing gate. A swing gate unit complete shall include one gate with necessary fittings, hardware and gate posts with braces.

**4.02 PAYMENT**

A. Automated vehicular swing gate operator system furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Swing Gates furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

C. Full compensation for furnishing and installing connections on swing gates, welding, drilling anchor bolt holes and bolts shall be considered as included in the prices and no additional compensation will be allowed.

D. Full compensation for clearing the line of the swing gate and disposing of the material, excavating high points in the existing ground, excavating and backfilling holes, disposing of surplus excavated material, and furnishing and placing concrete footings and connecting gate to structures shall be considered as included as listed on the Schedule of Quantities and Prices.

**END OF SECTION**
SECTION 32 32 16
GRAVITY BLOCK RETAINING WALLS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work involves furnishing all labor, materials and equipment necessary and incidental to constructing gravity block retaining walls to the limits and at the locations shown on the Contract Drawings and as modified by the Engineer. This work consists of furnishing and constructing gravity block retaining walls of prefabricated modular units at locations shown or as directed by the engineer, and in close conformity to the lines, grades, and dimensions shown or established.

B. Sections include but are not necessarily limited to:

1. Section 03 21 00 - Reinforcing Steel
2. Section 03 31 00 – Structural Concrete
3. Section 31 20 00 - Earthwork
4. Section 32 31 13 - Chain Link Fencing and Gates
5. Section 33 46 00 – Underdrains
6. Section 34 11 27 – Sub-ballast and Aggregate Base

1.02 SUBMITTALS

A. Shop drawing showing wall materials and construction details as provided by the supplier of the wall system. Drawings are to be certified by a qualified Engineer licensed in the State of California, and shall be suitable for obtaining City permits, as necessary.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Approved proprietary retaining wall systems, meeting these specifications are:

1. Enviro-Block by inter-Block Retaining Lock-Block Retaining Systems, San Marcos, CA. Telephone: 800-406-2066

2. Keystone Retaining Wall Systems, 4444 West 78th Street, Minneapolis, MN 55435 - Telephone 952-897-1040 or keystone@keystonewalls.com
3. Approved equal gravity retaining wall systems providing a pinned or interlocked type construction.

B. Blocks are to be standard grade, gray color with smooth face finish.

C. Blocks shall be sound and free of cracks or other defects that would interfere with the proper placement of the block or significantly impair construction of the wall.

D. Block face exposed to view shall be free of chips, cracks or other imperfections when viewed from a distance of 10 feet under diffused light.

E. Tolerance - Molded dimensions are not to differ more than 1/4 inch from the manufacturer's published dimensions, except height, which is not to differ more than 1/8 inch.

F. Geotextile fabric shall be Miraf “Filterweave 404” or approved equivalent.

2.02 ACCEPTANCE OF BLOCKS

A. Acceptability will be determined based on tolerances specified in 2.1 of this section and visual inspection. Any one of the following defects will be cause for rejection:

1. Concrete not suitable for common structural applications, Imperfect molding,

2. Honeycombed or open texture concrete,

3. Broken, cracked or chipped blocks, or

4. Extreme color variation on visible face of block.

PART 3 - EXECUTION

3.01 PREPARATION

A. Excavate existing material in accordance with Section 02300 as needed to construct the wall as detailed on the plans.

B. Prepare the subgrade in accordance with Section 02300 and suppliers recommendations.

3.2 ENVIROBLOCK WALL CONSTRUCTION

A. Place geotextile fabric over the full width and sides of the zone of unsuitable subgrade over excavation. Geotextile shall be laid smooth without wrinkles or folds in accordance with the manufacturer’s directions. Joints or overlaps are not allowed along the width of the excavation. Adjacent rolls of geotextile shall have a minimum overlap of 40 inches in the longitudinal direction. There shall be no wheeled or tracked equipment permitted on the unprotected geotextile fabric.
B. The zone of over excavation shall be backfilled with Class 2 Crushed Aggregate Base conforming to Section 32 11 00. An initial 6 to 12 inches of CAB shall be uniformly placed over the geotextile fabric as a protective covering. This initial protective layer shall not be compacted. Once the Engineer has determined that a stable condition has been achieved, the remaining CAB shall be placed in 8 to 10 inch lifts and compacted to 95% relative compaction at optimum moisture content (ASTM D 1557). Wheeled or tracked compaction equipment shall not be used until 24 inches of CAP has been placed on top of the geotextile fabric. The geotextile fabric at the sides of the excavation shall be protected from damage throughout the placement and compaction of the CAB. Damaged geotextile shall be repaired at the direction of the Engineer at no cost to SCRRA.

C. The top of the backfill shall be shaped to a slope to match the base of the lowest block. Each block shall be placed with full contact with the compacted base at the angle indicated on the approved submittal.

D. Block Installation and Backfill Placement - Blocks shall typically be placed in a running bond pattern unless placed perpendicular to the face of the wall. Place blocks so the final position is battered as shown. Place the first course of blocks on top of and in full contact with the prepared base pad surface.

E. Install drain pipe filter fabric and pervious rock in accordance with the plans and Section 33 46 00.

F. Closely follow erection of each course of blocks with placement of Embankment Fill (face opposite track) and drainage/subballast material (face on trackside). Remove excess backfill from the top of the blocks prior to installing the next course of blocks. Clean, free draining backfill and structural backfill to be as specified on the approved shop drawing.

G. During construction of the wall and placement of blocks maintain a vertical tolerance and tangent horizontal alignment tolerance not in excess of 1-1/8 inch when measured with a 10 foot straightedge. Check the batter and tolerances of each course of blocks before erecting the next course.

H. Form, install reinforcement and cast-in-place concrete curb with fence and gate post anchorage per Caltrans alternative anchorage detail on Standard Plan B11-7. Expansion joints in the curb shall be provided at 25 feet maximum to match running bond pattern. Reveals and chamfers shall be installed in the form to match the chamfered corners of the precast block and running bond pattern.

I. Remove forms, finish per Section 03 31 00, Structural Concrete. Clean exposed face of finished wall to remove all dirt, debris and marks caused during construction.

J. Grade embankment at top of wall in accordance with the plans.

K. Install fencing as indicated on the plans.
3.3 KEYSOTNE WALL CONSTRUCTION

A. Walls shall be installed in accordance with manufacturer’s shop drawings and standard details, with the addition of geotextile fabric as described above.

B. Grade embankment at top of wall in accordance with the plans.

C. Install fencing as indicated on the plans.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Gravity Block Retaining Wall will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the plans will be used as the basis for this measurement.

B. Gravity Block Retaining Wall shall include excavation, shoring, subgrade preparation, aggregate base geotextile fabric, pre cast blocks, forms, reinforcing steel (including drilling and bonding of dowels), cast-in-place concrete; structural backfill and other appurtenances for the retaining wall.

C. Perforated underdrain, filter fabric, permeable rock, subballast and fence are not included in payment for gravity retaining wall.

4.02 PAYMENT

A. Gravity Block Retaining Wall furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall be full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals necessary for Gravity Block Retaining Wall described by the Contract Documents.

END OF SECTION
SECTION 32 32 20
MECHANICALLY STABILIZED EARTH (MSE) RETAINING WALLS

PART 1 - GENERAL

1.01 SUMMARY

This work shall consist of furnishing materials and placement of mechanically stabilized earth walls constructed in accordance with these specifications and in reasonably conformity with the lines, grades, design, and dimensions shown on the plans or otherwise established, including gutters and cable railing and/or chain link fencing.

The mechanically stabilized earth wall shall consist of a leveling pad, concrete facing panels, and soil reinforcement elements mechanically connected to each facing panel. Soil reinforcement shall have sufficient length, strength, and frictional resistance as required by the design outlined in these specifications.

A. Section Includes:

1. Concrete retaining wall units
2. Reinforcement
3. Joint Material
4. Galvanizing
5. Inspection Elements
6. Soil Reinforcement
7. Drainage aggregate
8. Reinforced Backfill
9. Drainage System

B. Related Sections including but are not necessarily limited to:

1. Division 01 – General Requirements
2. Section 03 21 00 – Reinforcing Steel
3. Section 03 31 00 – Structural Concrete
4. Section 31 20 00 - Earthwork
5. Section 034 80 43 Precast and Prestressed Concrete for Bridges
1.02 REFERENCES

A. Comply with local, State, and Federal codes, regulations, specifications, standards and recommended practices.

B. American Association of State Highway Transportation Officials (AASHTO)
   1. M288 Geotextile Specification for Highway Applications
   2. Standard Specifications for Highway Bridges
   3. T-22 Compressive Strength of Cylindrical Concrete Specimens
   4. T-23 Making and Curing Concrete Test Specimens in the Field
   5. T-24 Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
   6. T-141 Sampling Freshly Mixed Concrete
   7. M-85 Standard Specifications for Portland Cement (Chemical and Physical)

C. American Society for Testing and Materials (ASTM)
   1. C140 Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
   2. C1262 Standard Test Method for Evaluating the Freeze-Thaw Durability of Manufactured Concrete Masonry Units and Related Concrete Units
   3. C1372 Standard Specification for Segmental Retaining Wall Units
   4. D448 Standard Classification for Sizes of Aggregate for Road and Bridge Construction
   5. D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³)(600 kN-m/m³)
   6. D1556 Standard Test Method for Density and Unit Weight of Soil In Place by the Sand Cone Method
   7. D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³) (2700 kN-m/m³)
   8. D2487 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
   9. D2922 Standard Test Methods for Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth)
10. D3034 Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer pipe and Fittings
17. D5321 Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
18. D5818 Standard Practice for Obtaining Samples of Geosynthetics from a Test Section for Assessment of Installation Damage
20. D6638 Standard Test Method for Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units
22. F405 Standard Specification for Corrugated Polyethylene (PE) Tubings and Fittings
24. D2000 Standard Classification System for Rubber products in Automotive Applications
25. A82/A82M Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
26. A185/A185M Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete

27. A496/A496M Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement


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

D. Federal Highway Administration


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

1.03 DEFINITIONS

A. Mechanically Stabilized Embankment Retaining Wall (MSE) Units: Dry-stacked concrete units used as the retaining wall fascia.

B. Reinforced Backfill: Soil which is used as fill behind the MSE unit, and within the reinforced soil mass (if applicable).

C. Drainage Aggregate: Material used (if applicable) within, between, and directly behind the concrete retaining wall units.

D. Geotextile Filter: Material used for separation and filtration of dissimilar soil types.

E. Foundation Soil: Soil mass supporting the leveling pad and reinforced soil zone of the retaining wall system.

F. Geosynthetic Reinforcement: Polymeric material designed specifically to reinforce the soil mass.

G. Pre-fabricated Drainage Composite: three-dimensional geosynthetic drainage medium encapsulated in a geotextile filter, used to transport water.
H. Impervious Materials: Clay soil or low permeability geosynthetic used to prevent water percolation into the drainage zone and reinforced backfill behind the wall.

I. Global Stability: The general mass movement of a soil reinforced segmental retaining wall structure and adjacent soil mass.

J. Project Geotechnical Engineer: A registered engineer who provides site observations, recommendations for foundation support, and verifies soil shear strength parameters.

1.04 SUBMITTALS

A. The Contractor may use a proprietary earth retaining system or an acceptable alternative, the Contractor shall submit complete working drawings for each installation of the system in conformance with the provisions in Division 01 for requirements for the mechanics and administration of the submittal process. Design drawings shall be submitted to the SCRRA for acceptance and approval.

B. Design drawings shall be 11" x 17" in size, and each drawing and calculation sheet shall include the State assigned designations for the contract number, bridge number, full name of the structure as shown on the contract plans, and District-County-Route-Post Mile. The design firm's name, address, and phone number shall be shown on the working drawings. Each sheet shall be numbered in the lower right hand corner and shall contain a blank space in the upper right hand corner for future contract sheet numbers.

C. The design drawing shall include all details, dimensions, quantities and cross-sections necessary to construct the wall and shall include but shall not be limited to the following:

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

E. A typical cross section or cross sections showing the elevation relationship between ground conditions and proposed grades.

F. General notes pertaining to design criteria and wall construction

G. A listing of the summary of quantities for each wall

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

I. Clearly indicated details for construction of walls around drainage facilities

J. Details of the architectural treatment
K. The details for diverting soil reinforcements around obstructions such as piles, catch basins and other utilities.

L. The details for connections between the concrete panel and the reinforcements.

M. The Contractor shall verify the existing ground elevations at the site before preparing the working drawings. The working drawings shall contain all information required for the proper construction of the system at each location including existing ground line at face of wall as verified at the site and any required revisions or additions to drainage systems or other facilities. The working drawings shall include "General Notes" that contain design parameters, material notes, and wall construction procedures and shall be accompanied with calculations. The working drawings and calculations shall be stamped and signed by an engineer who is registered as a Civil Engineer in the State of California. The Contractor shall allow the Engineer 30 days to review the drawings after a complete set has been received.

N. Unless otherwise specified, at the completion of each structure for which working drawings were submitted and if the work detailed in these working drawings is permanent, the Contractor shall submit to the Engineer one set of corrected as-built prints 11" x 17" in size and on 20-pound (minimum) bond paper, showing as-built conditions. As-built drawings that are common to more than one structure shall be submitted for each structure.

O. Due to the nature of MSE Retaining Wall Systems, contractors shall provide a system specific submittal package to the Civil Engineer at least thirty (30) days prior to construction for approval. Incomplete submittal packages will not be reviewed.

Submit the following at least thirty (30) days prior to construction for approval:

1. Product Data
   a. Material description and installation instructions for each manufactured product specified including Mechanically Stabilized Embankment (MSE) and soil reinforcement.
   b. Name and address of the production facility where the proposed MSE units will be manufactured. All units to be manufactured at the same facility.
   c. Notarized letter from the MSE manufacturer stating that the units supplied for this project are manufactured in complete compliance with Section 2.01 of this specification. The letter shall state that the MSE units shown in the attached test reports are representative samples of the plants normal mix design and regular production runs.

2. Test Reports:
a. Independent laboratory reports indicating compressive strength, moisture absorption and freeze-thaw durability of the concrete retaining wall units from the proposed production facility. Only test performed within the past 12 months will be considered current and valid.

b. Independent test reports verifying the long-term design strength properties (creep, installation damage, and durability) and soil interaction properties of the geosynthetic reinforcement.

c. Independent test reports verifying the connection capacity between the geosynthetic reinforcement and the concrete retaining wall units.

3. Retaining Wall Final Design Submittals

a. Shop Drawings: For initial review, Five (5) sets of the retaining wall system design, including wall elevation views, geosynthetic reinforcement layout, pertinent details, and drainage provisions. A registered professional engineer licensed in the state of wall installation shall sign and certify that the shop drawings are designed in accordance with the project civil plans and specifications. After review, between six (6) to twelve (12) sets of the retaining wall system design, including wall elevation views, soil reinforcement layout, pertinent details, and drainage provisions shall be submitted for final approval and use during construction. A registered professional engineer licensed in the state of wall installation shall sign and certify that the shop drawings are designed in accordance with the project civil plans and specifications.

b. Design Calculations: Four (4) sets of engineering design calculations prepared in accordance with SCRRA Design Criteria Manual. Analysis shall include Internal, External, Global Stability, and Bearing Capacity Calculations.

1.05 DESIGN REQUIREMENTS

A. Designs for MSE’s using extensible soil reinforcement shall be prepared according to design methodology presented in the SCRRA Design Criteria Manual. Design submittals not meeting this design criteria or technical/administrative criteria as specified will be rejected in their entirety until complete compliance is achieved. Owner reserves all rights in determining compliance for plan approval and may reject any submittals.

B. Design of the MSE shall be based on the soil parameters as determined during the geotechnical investigation as provided in the Plans.

C. The Design Engineer of Record shall be responsible for selecting and specifying reinforced fill material. The General Contractor is responsible for ensuring and
documenting the reinforced fill meets the specified parameters for both strength 
and compaction. Compacted retained soil shall meet the minimum requirements 
specified.

D. The minimum factors of safety shall be as follows:

1.5 against pullout of the reinforcements based on pullout resistance at 0.5 inch 
deformation for a representative backfill. (i.e. the resulting deformation should 
not exceed 0.5 inch times the design load)

1.5 against sliding of the mass

2.0 against overturning of the mass

2.0 against panel connection pullout or rupture, and 1.5 against a panel 
connection deformation of 0.5 inch under the maximum allowable reinforcement 
tension. (i.e. the resulting deformation should not exceed 0.5 inch at 1.5 times 
the design load).

1.06 DELIVERY, STORAGE AND HANDLING

A. Concrete Retaining Wall Units and Accessories: Deliver, store, and handle 
materials in accordance with manufacturer's recommendations, in such a manner 
as to prevent damage. Check the materials upon delivery to assure that proper 
material has been received. Store above ground on wood pallets or blocking. Remove and replace damaged or otherwise unsuitable material, when so 
determined, from the site.

B. Exposed faces of concrete wall units shall be free of chips, cracks, stains, and 
other imperfections detracting from their appearance, when viewed from a 
distance of 10 feet.

C. Prevent mud, wet cement, adhesives and similar 
materials that may harm 
appearance of units, from coming in contact with system components.

D. Panels shall be stored and shipped in stacks, front face down. Firm blocking, of 
sufficient thickness to prevent the attachment devices from contacting the panel 
above, shall be located immediately adjacent to the attachment devices. Lifting 
inserts shall be installed on the top edge of the precast panels to permit lifting at 
the project site. Reinforcement connection inserts (tie strips or loop inserts) shall 
not be used for lifting or handling the panels.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Concrete Retaining Wall Units
1. Concrete used in precast and cast-in-place reinforced concrete members of earth retaining structures shall conform to the details shown on the plans, the provisions in Section 03 30 00.

2. Concrete facing panels shall have a minimum thickness of 5 ½ inches and a minimum concrete cover on reinforcing steel of 1-1/2 inches. Cement shall be Type I, II or III and shall conform to the requirements of AASHTO M-85. Additives containing chloride shall not be used without the approval of the Engineer. Attachment devices and lifting devices shall be set in place to the dimensions and tolerances shown on the plans and called out in these specifications prior to casting.

3. Acceptability of the precast units shall be determined on the basis of compressive strength tests and visual inspection. The precast units shall be considered acceptable regardless of curing age when compressive strength test results indicate that the compressive strength will conform to the 28-day requirement. The Contractor, or his supplier, shall furnish facilities and perform all necessary sampling and testing in an expeditious and satisfactory manner. Panels utilizing Type I or II cement shall be considered acceptable for placement in the wall when the seven-day initial strength equals or exceeds 85 percent of the 28-day requirement.

4. The panels shall be cast face down in level forms supported on a flat working surface. Guides shall be used to locate and support attachment devices set in the back face of the panel. The concrete in each panel unit shall be placed without interruption and shall be consolidated by the use of an approved vibrator, supplemented by such hand tamping as may be necessary to force the concrete into the corners of the forms and to prevent the formation of stone pockets or cleavage planes. Clear form oil or release agent shall be used throughout the casting operation.

5. The units shall be cured for a sufficient length of time so that the concrete will develop the specified compressive strength. Any production lot which does not conform to the strength requirements shall be rejected.

6. The forms shall remain in place until they can be removed without damage to the unit.

7. Unless otherwise indicated on the plans or elsewhere in the specifications, the concrete surface for the front face shall have an ordinary steel form finish, and for the rear face an unformed finish. The rear face of the panel shall be free of open pockets of aggregate and surface distortions in excess of ¼ inch.

8. All units shall be manufactured within the following tolerances with respect to the dimensions shown on the shop drawings.
a. Attachment Device Locations and Alignment - Lateral position of reinforcing strip attachment devices shall be within one inch. Embedment measured from the back face of the panel shall be within + ¼ inch, − ½ inch. Bearing surfaces of multiple attachment points for a single soil reinforcing element shall align within 1/16 inch.

b. Panel Dimensions - All panel dimension shall be within ¼ inch. All hardware embedded in the panel with the exception of attachment devices shall be within ¼ inch.

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

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

9. Acceptance of the concrete panels, with respect to compressive strength, shall be determined on the basis of production lots. A production lot is defined as a group of panels that shall be represented by a single set of compressive strength samples and shall consist of not more than 80 panels or a single day’s production, whichever is less.

a. Compressive strength tests shall be performed on 6-inch diameter by 12-inch cylinders prepared in accordance with AASHTO T-23. During the production of the concrete panels, the manufacturer shall randomly sample the concrete in accordance with AASHTO T-141. A single set of compressive strength samples, consisting of a minimum of four (4) cylinders, shall be made for every production lot.

b. For every compressive strength sample, a minimum of two cylinders shall be cured in the same manner as the panels and tested at seven (7) days or less. The average compressive strength of these cylinders, when tested in accordance with AASHTO T-22, will determine the initial strength of the concrete. In addition, a minimum of two cylinders shall be cured in accordance with AASHTO T-23 and tested at 28 days. The average compressive strength of these cylinders, when tested in accordance with AASHTO T-22, will determine the compressive strength of the production lot.

c. If the initial strength test result indicates a compressive strength greater than or equal to 4,000 pounds per square inch, then this test result will be utilized as the compressive strength test result for that production lot, and the requirement for testing at 28 days will be waived for that particular production lot.
d. Acceptance of a production lot will be made if the compressive strength test result is greater than or equal to 4,000 pounds per square inch. If the compressive strength test result is less than 4,000 pounds per square inch, the acceptance of the production lot will be based on its meeting the following acceptance criteria in its entirety:

1) Ninety (90) percent of the compressive strength test results for the overall production shall exceed 4,150 pounds per square inch.

2) The average of any six (6) consecutive compressive strength test results, including the one in question, shall exceed 4,250 pounds per square inch.

3) No individual compressive strength test result shall fall below 3,600 pounds per square inch.

e. In the event that a production lot fails to meet the specified compressive strength requirements, the production lot shall be rejected. Such rejection shall prevail unless the manufacturer, at his own expense, obtains and submits evidence of a type acceptable to the Engineer that the strength and quality of the concrete placed within the panels of the production lot is acceptable. If such evidence consists of tests made on cores taken from the panels within the production lot, the cores shall be obtained and tested in accordance with AASHTO T-24.

10. Precast panels shall be accepted for use in wall construction provided the concrete strength meets or exceeds the minimum compressive strength requirement, the soil reinforcement connection devices and the panel dimensions are within tolerances and any chipping, cracks, honeycomb or other defects are within acceptable standards for precast concrete as determined by the Engineer.

11. It is recognized that certain cracks and surface defects are not detrimental to the structural integrity of the panel if properly repaired. The Engineer shall determine the need for and proper method of such repair. All repairs shall be approved by the Engineer prior to acceptance of the panel for use in wall construction.

12. The date of manufacture, the production lot number, and the piece-mark shall be clearly marked on the side of each panel.

13. The concrete leveling pads for the Mechanically Stabilized Embankment (MSE) system shall conform to the provisions in the Caltrans Standard Specifications, Section 90-10, “Minor Concrete.”

B. Reinforcement

1. Reinforcement shall conform to the provisions in Section 03 21 00.
C. Joint Material

Installed to the dimensions and thicknesses in accordance with the plans or approved shop drawings.

1. Bearing Pads
   
a. Bearing pads shall be EPDM rubber pads conforming to ASTM D-2000 M2AA 807, having a durometer hardness of 80 +/- 5.

2. Joint Cover
   
a. Where required, as shown on the plans, horizontal and vertical joints between panels shall be covered by a geotextile. The geotextile may be either a non-woven needle punched polyester geotextile or a woven monofilament polypropylene geotextile as approved by the wall supplier. Adhesive used to hold the geotextile filter fabric material to the rear of the facing panels prior to backfill placement shall be approved by the wall supplier.

D. Galvanizing

1. Soil reinforcement, connecting elements, and other steel components that are in contact with the earth shall be galvanized in conformance with the provisions in the Caltrans Standard Specifications, Section 75-1.05, "Galvanizing."

E. Inspection Elements

1. If a proprietary alternative system is selected, inspection elements representative of the particular soil reinforcement shall be furnished in the same number and approximate location as shown on the plans for the MSE system.

2. When metallic soil reinforcement is used, the threaded end of the inspection wire may be formed before or after galvanizing. The end 4 inches of the wire shall be coated with two applications of an approved unthinned commercial quality zinc-rich primer (organic vehicle type). The threaded end of the wire shall be encapsulated with corrosion inhibiting, mastic filled, round vinyl enclosure secured with a nylon tie as shown on the plans. If the threaded end is galvanized after threading, the threads shall be cleaned before painting. There shall be no damage to the unthreaded portion of the galvanized inspection wire.

F. Soil Reinforcement

1. Soil reinforcement shall conform to the details shown on the contract plans, the approved working drawings, the preapproved proprietary system details, and these special provisions.
2. W11 and W20 steel wire shall conform to the requirements in ASTM Designation: A 82/A 82M. The welded wire mat shall conform to the requirements in ASTM Designation: A 185/A 185M. D11 and D20 deformed steel wire may be substituted for W11 and W20 steel wire, respectively. The welded wire mat utilizing deformed steel wire shall conform to the requirements in ASTM Designation: A 496/A 496M and ASTM Designation: A 497/A 497M.

3. The button on button-head wires shall conform to the provisions in the Caltrans Standard Specifications, Section 50-1.05, "Prestressing Steel."

4. The coupler at the wire mat connection shall be a seamless steel sleeve. The coupler shall be applied over the button-head wires and swaged by means of a hydraulic press. The coupler shall develop the minimum tensile strength of the wire without exceeding a total slip of the wires of 3/16 inch.

5. Sample button-head wire and coupler connectors shall develop the minimum tensile requirements for W11 and W20 steel wire in ASTM Designation: A 82/A 82M without exceeding a total slip of the wires of 3/16 inch when tested in conformance with the provisions for tension testing of round wire samples in ASTM Designation: A 370. When D11 and D20 deformed steel wire are substituted, samples shall develop the minimum tensile requirements contained in ASTM Designation: A 496/A 496M. An independent testing laboratory shall perform button-head wire and coupler connection testing. Samples shall consist of 2 button-head wires each 24 inches long connected by a swaged coupler.

6. Prior to the start of wall construction, the Contractor shall furnish test results to the Engineer from tension and slip tests conducted on 6 proposed button-head wire and coupler connections. Failure of any of the proposed button-head wire and coupler connector samples to meet the slip and tensile strength requirements herein shall require the connection be redesigned by the Contractor.

7. No installation of face panels shall be allowed until the Contractor has successfully completed tension and slip testing for proposed button-head wire and coupler connectors.

8. During wall construction, the Contractor shall furnish test results to the Engineer from tension and slip testing of 4 samples of production button-head wire and coupler connections for each lot of 500 individual mat wire connections incorporated into the work. Production testing shall consist of testing each of the 4 sample connections for both slip and tensile requirements herein. If 2 or more of the production samples fail to meet slip or tensile test requirements, the entire lot represented by these samples shall be rejected. If one of the production samples fails to meet slip or tensile test requirements, an additional 4 samples shall be tested. Should any of the additional samples fail to meet the slip or tensile requirements, the entire lot represented by these samples shall be rejected.
9. Splicing of the welded wire mat along its length shall be by mechanical coupler that shall develop the minimum tensile strength of the wire. The mechanical coupler shall be approved by the Engineer.

10. Geogrid soil reinforcement roll identification, storage, and handling shall be in accordance with ASTM Designation: D 4873, and as specified in the preapproved proprietary details. The geogrid shall be shipped and stored such that the material is not placed directly on the ground. The geogrid shall be covered and protected at all times during shipment and storage such that it is fully protected from UV radiation including sunlight, site construction damage, precipitation, chemicals, flames including welding sparks, temperatures less than 20 °F or greater than 140 °F, or other conditions that may damage the physical property values of the geogrid. The Contractor shall prevent foreign materials from coming into contact with or affixing to the geogrid.

G. Reinforced Backfill:

1. Excavation and backfill shall conform to the details shown on the plans, the provisions in Section 31 20 00.

2. Structure backfill for earth retaining structures with soil reinforcement shall be free of organic material and debris and substantially free of shale or other soft materials of poor durability. Structure backfill shall not contain slag aggregate or recycled materials such as glass, shredded tires, portland cement concrete rubble, asphaltic concrete rubble, or other unsuitable material as determined by the Engineer.

   a. GP, GW, SP, SW, or SM soil types, classified in accordance with ASTM D2487 and the USCS classification system, may be used for all design heights

   b. SC, ML and CL soil types, classified in accordance with ASTM D2487 and the USCS classification system, are considered suitable soils with a total height of 10 feet or less.

   c. CH, OH, MH, OL, or PT soil types, classified in accordance with ASTM D2487 and the USCS classification system, shall not be used.

   d. Draining System

3. Structure backfill for earth retaining structures with soil reinforcement other than geosynthetic shall conform to the following requirements or the requirements of the proprietary wall system, if more restrictive:
Gradation Requirements

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percentage Passing</th>
<th>California Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>6&quot;</td>
<td>100</td>
<td>202</td>
</tr>
<tr>
<td>3&quot;</td>
<td>78-100</td>
<td>202</td>
</tr>
<tr>
<td>No. 4</td>
<td>----</td>
<td>202</td>
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<tr>
<td>No. 30</td>
<td>0-60</td>
<td>202</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-15</td>
<td>202</td>
</tr>
</tbody>
</table>

Property Requirements

<table>
<thead>
<tr>
<th>Test</th>
<th>Requirement</th>
<th>California Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand Equivalent</td>
<td>12 minimum</td>
<td>217</td>
</tr>
<tr>
<td>Plasticity Index</td>
<td>6 maximum</td>
<td>204</td>
</tr>
<tr>
<td>Minimum Resistivity</td>
<td>2000 ohm-cm</td>
<td>643</td>
</tr>
<tr>
<td>Chlorides</td>
<td>&lt; 250 ppm</td>
<td>422</td>
</tr>
<tr>
<td>Sulfates</td>
<td>&lt; 500 ppm</td>
<td>417</td>
</tr>
<tr>
<td>pH</td>
<td>5.5 to 10.0</td>
<td>643</td>
</tr>
</tbody>
</table>

If 12 percent or less passes the No. 200 sieve and 50 percent or less passes the No. 4, the Sand Equivalent and Plasticity Index requirements shall not apply.

4. Structure backfill for earth retaining structures with geosynthetic soil reinforcement shall conform to the following requirements:

Gradation Requirements

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percentage Passing</th>
<th>California Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot;</td>
<td>100</td>
<td>202</td>
</tr>
<tr>
<td>No. 4</td>
<td>50-80</td>
<td>202</td>
</tr>
<tr>
<td>No. 40</td>
<td>0-30</td>
<td>202</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-15</td>
<td>202</td>
</tr>
</tbody>
</table>

Property Requirements

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<thead>
<tr>
<th>Test</th>
<th>Requirement</th>
<th>California Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand Equivalent</td>
<td>30 minimum</td>
<td>217</td>
</tr>
<tr>
<td>Plasticity Index</td>
<td>6 maximum</td>
<td>204</td>
</tr>
<tr>
<td>Durability Index</td>
<td>35 minimum</td>
<td>229</td>
</tr>
<tr>
<td>pH</td>
<td>4.5 to 9.0</td>
<td>643</td>
</tr>
</tbody>
</table>

5. Permeable material shall be used for the portion of the structure backfill for earth retaining structures with soil reinforcement within the limits shown on the plans. Permeable material shall be Class 1, Type B, conforming to the provisions in the Caltrans Standard Specification, Section 68-1.025, "Permeable Material."
6. Permeable material for earth retaining structures with metallic soil reinforcement shall conform to the following requirements:

<table>
<thead>
<tr>
<th>Property Requirements</th>
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</thead>
<tbody>
<tr>
<td>Test</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>Minimum Resistivity</td>
</tr>
<tr>
<td>Chlorides</td>
</tr>
<tr>
<td>Sulfates</td>
</tr>
<tr>
<td>pH</td>
</tr>
</tbody>
</table>

7. Permeable material for earth retaining structures with geosynthetic soil reinforcement shall conform to the following requirements:

<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>Test</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>pH</td>
</tr>
</tbody>
</table>

8. Water used for earthwork or dust control within 500 feet of earth retaining structures with metallic soil reinforcement shall conform to the provisions for water in the Caltrans Standard Specifications, Section 90-2.03, "Water."

9. The drainage system shall conform to the details shown on the plans and these special provisions.

10. Corrugated steel pipe shall conform to the provisions in the Caltrans Standard Specifications, Section 66, "Corrugated Metal Pipe."

11. Perforated steel pipe underdrains and underdrain outlets and risers shall conform to the provisions in the Caltrans Standard Specifications, Section 68-1, "Underdrains,"

12. The class of rock used for rock slope protection at drain pipe outlets shall be No. 3 Backing and shall conform to the provisions in the Caltrans Standard Specifications, Section 72-2, "Rock Slope Protection."

13. Filter fabric shall conform to the provisions in the Caltrans Standard Specifications, Section 88-1.02, "Filtration." Filter fabric shall be Class A.


H. Miscellaneous
1. Resin bonded cork for horizontal joints shall conform to the requirements in ASTM Designation: D 1752, Type II, with a compressive load of not less than 100 psi.

2. Pipe for the pipe pin shall conform to the requirements in ASTM Designation: A 53/A 53M, Standard weight, except the amount of the zinc coating per square foot of actual surface shall average not less than 2.0 ounces and no individual specimen shall be less than 1.8 ounces.

PART 3 - CONSTRUCTION

Earth retaining structures shall be constructed to the lines, grades, and details shown on the plans, and shall conform to these special provisions.

3.01 EARTHWORK

A. The foundation for the structure shall be graded level for a width equal to the length of soil reinforcement elements plus 12 inches or as shown on the contract plans. The foundation material shall be compacted to a relative compaction of not less than 95 percent. The Engineer shall approve the compacted foundation area prior to commencement of wall construction.

B. The Contractor shall remove unsuitable material as determined and directed by the Engineer. This work shall be paid for as extra work as provided in the Caltrans Standard Specifications, Section 4-1.03D, "Extra Work."

C. Structure backfill material shall be placed and compacted simultaneously with the erection of the facing panels. Placement and compaction shall be accomplished without distortion of the soil reinforcement or displacement of facing panels. Structure backfill at the front of the wall shall be completed prior to backfilling more than 15 feet above the bottom of the lowermost face element.

D. Vertical and horizontal alignment tolerances of panels shall not exceed 3/4 inch when measured along a 10-foot straightedge. The maximum allowable offset in any panel joint shall not exceed 3/4 inch.

E. Structure backfill for earth retaining structures with soil reinforcement shall be compacted to a relative compaction of not less than 95 percent.

F. A relative compaction of not less than 95 percent shall be obtained for embankment under earth retaining structures with soil reinforcement within the limits established by inclined planes sloping 1.5:1 (horizontal:vertical) out and down from lines one foot outside the bottom limits of the structure, including permeable material when required.

G. Soil reinforcement shall be tensioned in the direction perpendicular to the wall face with enough force to remove any slack in the connection or in the soil reinforcement itself. Soil reinforcement shall be secured in place to prevent movement during placement of additional soil reinforcement and structure backfill until the initial lift of structure backfill is compacted.
H. Geogrid soil reinforcement shall be placed in full-length sections.

I. Soil reinforcement shall be covered with structure backfill during the same work shift that it is placed.

J. Placement and compaction of structure backfill shall begin one foot from the back face of wall panels and progress towards the free end of the soil reinforcement. Compaction equipment shall be operated parallel to the wall facing. The remaining width of backfill behind the wall panels shall be placed and compacted after soil reinforcement has been covered to a depth of 6 inches.

K. Sheepsfoot or grid-type rollers shall not be used for compacting material within the limits of the soil reinforcement. Hand-held or hand-guided compacting equipment shall be used to compact structure backfill material within 3 feet of the facing panels.

L. Construction equipment shall not be operated directly on the soil reinforcement. A layer of structure backfill material not less than 6 inches in thickness shall be maintained between the soil reinforcement and construction equipment of any type.

M. Structure backfill material for earth retaining structures with geogrid soil reinforcement shall be placed in lifts not to exceed 6 inches where hand-operated compacting equipment is used and 8 inches where heavy compaction equipment is used.

N. At each level of the soil reinforcement the structure backfill shall be constructed to a plane 2 inches above the elevation of the soil reinforcement connection and shall start 3 feet from the back of the face panel and extend for at least the remaining length of soil reinforcement. This grading shall be complete before placing the next layer of soil reinforcement.

O. Permeable material and filter fabric shall be placed along with structure backfill as shown on the plans. Permeable material shall be placed in layers not exceeding 2 feet in thickness. Compaction of the permeable material for the drainage system outside the limits of the soil reinforcement is not required, and equipment shall not be operated directly on the permeable material or filter fabric. If a sloped layer of permeable material is placed to facilitate the work or to satisfy safety considerations, the vertical limits of permeable material shall remain unchanged and the thickness of the layer of permeable material shall be measured normal to the slope.

P. The Contractor shall grade the reinforced backfill to rapidly drain away from the wall face at the end of each work shift. Berms or ditches shall be provided to direct runoff away from the wall site. The Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

3.02 FILTER FABRIC

A. Filter fabric shall be placed at the locations and in conformance with the details shown on the plans and these special provisions.
B. Immediately prior to placing filter fabric, the subgrade to receive the filter fabric shall conform to the compaction and elevation tolerance specified for the material involved and shall be free of loose or extraneous material and sharp objects that may damage the filter fabric during installation.

C. Concrete panel surfaces to receive filter fabric shall be dry and thoroughly cleaned of dust and deleterious materials.

D. Filter fabric shall be handled and placed in conformance with the manufacturer's recommendations.

E. Filter fabric shall be stretched, aligned, and placed in a wrinkle-free manner.

F. Adjacent borders of filter fabric shall be stitched or overlapped from 12 inches to 18 inches. The preceding roll shall overlap the following roll in the direction the material is being spread or shall be stitched. When filter fabric is joined by stitching it shall be stitched with yarn of a contrasting color. The size and composition of the yarn shall be as recommended by the filter fabric manufacturer. The stitches shall number 5 to 7 per inch of seam.

G. If the filter fabric is damaged during installation, it shall be repaired by placing a piece of filter fabric that is large enough to cover the damaged area and that meets the overlap requirement.

H. During spreading of the permeable material, a minimum of 6 inches of the material shall be maintained between the filter fabric and the Contractor's equipment. Where structure backfill material is to be placed on filter fabric, a minimum of 18 inches of structure backfill material shall be maintained between the filter fabric and the Contractor's equipment. Equipment or vehicles shall not be operated or driven directly on filter fabric.

3.03 CONCRETE

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

B. After placement of an inspection element and placement of backfill to a level at least 2 feet above the inspection element, the void in the face panel shall be dry packed with mortar as shown on the plans. Dry pack shall conform to the provisions in the Caltrans Standard Specifications, Section 51-1.135, "Mortar," except that the proportion of cementitious material to sand shall be that required to achieve a 28-day mortar compressive strength of 1000 psi to 1500 psi.
3.04 PROPRIETARY EARTH RETAINING SYSTEMS

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

B. The Contractor shall supply a Certificate of Compliance conforming to the provisions in the Caltrans Standard Specifications, Section 6-1.07, "Certificates of Compliance," stating the supplied material meets the respective index criteria set forth when the proprietary alternative earth retaining system was prequalified by the Department, as measured in accordance with all test methods and standards specified in the Standard Specifications, these special provisions, and the approved working drawings.

C. A qualified representative of the proprietary earth retaining system manufacturer shall be present during erection and backfill of the first 10 feet of height of the entire length of the wall(s) and shall be available during any remaining installations. The manufacturer's representative shall not be an employee of the Contractor.

D. Alternative earth retaining structures shall be constructed to accommodate the wall-mounted lighting, the wall mounted drainpipe, and the panels for future drainage inlets, as shown on the plans. The top of wall profile of alternative earth retaining systems shall conform to the profile shown on the plans. The bottom of wall elevations or face panels shall be at or below the elevations shown on the plans. The height and length to be used for any system shall be the minimums for that system that will effectively retain the earth behind the structure for the loading conditions and the contours, profile, or slope lines shown on the plans. The length of soil reinforcement for any system shall be not less than that shown on the plans. In addition, if the plans or special provisions indicate limiting parameters for alternative systems, the system shall conform to those parameters.

E. The top of face panels, assuming no leveling pad settlement, shall be covered by the coping lip or concrete barrier slab lip at a minimum of 9 inches.

F. The top level of soil reinforcement shall be placed parallel to the top of the concrete panel at a distance below the top of the wall as shown on the plans. The top level of soil reinforcement shall also be (1) placed a minimum of 3 inches below the bottom of the barrier slab lip or the bottom of the concrete gutter behind coping and (2) placed a minimum of 5 inches below the top edge of the concrete panel.
PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. MSE Retaining Walls will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Regardless of the type of earth retaining structure actually constructed, the payment will be based on the length and vertical height of each section of system shown on the plans that was or would have been constructed. The vertical height of each section will be taken as the difference in elevation on the outer face from the bottom of the lowermost face element or top of footing to the top of wall profile.

4.02 PAYMENT

A. MSE Retaining Walls furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. The contract price paid for MSE Retaining Walls at each location shown on the plans shall include earthwork, leveling pad, coping, bearing pads, and drainage systems, Caltrans concrete gutters, handrails, complete in place, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

C. Full compensation for furnishing and testing sample mechanical connectors shall be considered as included in the contract price paid per square foot for earth retaining structure, and no separate payment will be made therefore.

D. Full compensation for revisions to the drainage system, or other facilities made necessary by the use of an alternative earth retaining system shall be considered as included in the contract price paid per square foot for earth retaining structure, and no separate payment will be made therefore.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. The Contractor shall provide all work necessary to design, install and make functional in place, all irrigation systems shown on the Submittal Drawings and/or specified herein.

1. Connections to services.

2. Complete installation of pipe lines and accessories for a complete sprinkler system including trenching, backfilling, valves, controllers, valve boxes, connections to existing electrical supply, cutting and patching as necessary.

3. All hose bibs and quick couplers necessary.

4. Protect all existing utilities and repair any damage to existing utilities with matching new materials, at no increase in contract price.

5. As-built drawings showing the piping schematic and layout.

6. Clean-up.

7. Final Inspection.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 26 05 00 – Basic Electrical Materials and Methods

2. Section 32 90 00 – Landscaping

1.02 SUBMITTALS

A. Submit a landscaping and landscape Irrigation Sprinkler system design meeting the requirements of the local agency requirements.

B. Submit complete materials list of all manufactured products to be installed on the site. Provide manufacturer’s name, model number, quantity and size. Note clearly all products which are not as specified and are submitted for approval as equal products.

1.03 CONDUCT OF WORK

A. The Contractor shall maintain continuously, a competent superintendent or
foreman, satisfactory to Engineer, on the work during progress, with authority to act for him in all matters pertaining to the work.

B. Work shall be coordinated with other trades so as to provide a complete, functional system.

### 1.04 GENERAL REQUIREMENTS

A. Before proceeding with any work, the Contractor shall carefully check and verify all dimensions. Spacing of sprinkler heads and locations of valves and backflow preventer shall be as indicated on the Contractor submittal.

B. Grading: Before starting work on the irrigation system, the Contractor shall inspect the site and check all grades to satisfy that the work may proceed safely.

C. Water Supply: The sources of water supply shall be from the potable water pipeline shown on the Submittal Drawings. Contractor to verify existing static pressure as indicated on the plans prior to beginning irrigation construction. Contractor to notify Engineer immediately should there be any discrepancy between the required pressure and the actual pressure on site.

D. Permits and Fees: The Contractor shall apply for all necessary permits required in the pursuit of his work as required by governing codes.

E. Record and As-Built Drawings:

1. The Contractor shall provide, keep up to date and complete "as-built" record set of drawings which shall show the exact "as-built" locations, sizes, and kinds of equipment. Prints for these purposes may be obtained from the Engineer at cost. This set of drawings shall be kept on the site until construction is complete.

2. The Contractor shall dimension from two (2) permanent points of reference, building corners, sidewalk, or road intersections, etc., the location of the following items:
   
a. Connection to existing water lines
b. Connection to existing electrical power
c. Gate valves
d. Routing of sprinkler pressure lines (dimension max. 100' along routing)
e. Sprinkler control valves
f. Quick coupling valves

h. Other related equipment

4. On or before the date of the final inspection, the Contractor shall deliver the corrected and completed sepias to the Engineer. Delivery of the sepias will not relieve the Contractor of the responsibility of furnishing required information that may be omitted from the prints.

F. Controller Charts:

1. As-built drawings shall be approved by the Engineer before controller charts are prepared.

2. Provide two controller charts for each controller supplied.

3. The chart shall show the area controlled by the automatic controller and shall be the maximum size which the controller door will allow.

4. The chart is to be a reduced drawing of the actual as-built system. However, in the event the controller sequence is not legible when the drawing is reduced, it shall be enlarged to a size that will be legible when reduced. Controller chart size shall be approved by the Engineer.

5. The chart shall be a black line or blue line print, and a different color shall be used to indicate the area of coverage for each station.

6. When completed and approved, the chart shall be hermetically sealed between two pieces of plastic, each piece being a minimum 10 mils.

7. These charts shall be completed and approved prior to final inspection of the irrigation system.

G. Irrigation Contractor shall be responsible for full coverage of irrigation system.

H. Operation and maintenance Manuals:

1. Prepare and deliver to the Engineer within ten calendar days prior to completion of construction, two hard cover binders with three rings containing the following information.

   a. Index sheet stating contractor's address and telephone number, list of equipment with name and addresses of local manufacturer's representatives.

   b. Catalog and parts sheets on every material and equipment installed under this contract.

   c. Guarantee statement.
d. Complete operating and maintenance instruction on all major equipment.

2. In addition to the above mentioned maintenance manuals, provide the Owner’s maintenance personnel with instructions for major equipment and show evidence in writing to the Architect at the conclusion of the project that this service has been rendered.

I. Equipment to be Furnished:

1. Supply as a part of this contract the following tools:

   a. Two (2) sets of special tools required for removing, disassembling and adjusting each type of sprinkler and valve supplied on this project.

   b. Two (2) keys for each automatic controller.

   c. Two (2) quick coupler keys and matching hose swivels for each type of quick coupling valve installed.

2. The above mentioned equipment shall be turned over to the Engineer at the conclusion of the project. Before final inspection can occur, evidence that the Owner has received material must be shown to the Engineer.

PART 2 - PRODUCTS

2.01 GENERAL

   A. All material shall be new stock and best grade of its kind. It shall be as specified unless otherwise specifically approved, in writing, by the Engineer. Materials not named shall be subject to approval or rejection by the Engineer.

2.02 PIPING

   A. Plastic Pipe:

      1. Plastic pipe and fittings shall be virgin hi-impact poly-vinyl chloride Type 2 conforming to commercial standards of National Sanitation foundation.

      2. All plastic pipe shall be continuously and permanently marked with the following information: Manufacturer’s name, kind of pipe, material size, IPS, NSF approval and schedule and type.

      3. Plastic pipe shall be as manufactured by Lasco, Baldwin, GSR, Pacific Wester, Johns Manville, or approved equal.
B. Main Lines:
   1. All piping and fittings under constant pressure between backflow preventer and control valves, quick couplers and hose bibs shall be as indicated per Approved Drawings.
   2. All main line piping and fittings under tracks and up to 10 feet beyond centerline of tracks shall be PVC Schedule 80.

C. Lateral Lines:
   1. All piping and fittings under intermittent pressure, down stream of control valves shall be rigid PVC 1120, Schedule 40, Type I, Grade I or II and shall meet ASTM-D 1785-86 standards.

2.03 FITTINGS

A. Fittings, Nipples and Risers:
   1. Plastic fittings shall be rigid poly-vinyl chloride, standard weight, schedule of pipe being fitted.
   2. Fittings for quick coupler shall be as specified on Submittal Drawings.
   3. Risers shall be PVC Schedule 80 or as specified on Submittal Drawings.
   4. Street Elbows, Bushings, Close Nipples, Long Screw, Bullhead Tees or Crosses will not be allowed and shall not be installed except as otherwise specified or detailed herein.

B. Brass Pipe and Fittings:
   1. Where indicated on the Submittal Drawings, use red brass screwed pipe conforming to Federal Specification #WW-P-351.
   2. Fittings shall be red brass conforming to Federal Specifications #WW-P-460.

2.04 AUTOMATIC CONTROLLERS

Controller shall be as specified on approved Submittal Drawings. Controllers shall be installed as per manufacturer's specifications. Verify location of electrical service of Controllers. Controllers to be compatible with Rainbird Maxicom Cluster Control Units (ESP.MC).

2.05 VALVES

A. Remote Control Valves:
   1. Remote control valves shall be as specified on Submittal Drawings and
installed in accordance with the details thereof.

B. Ball Valves:
   1. Ball valves shall be as specified on Submittal Drawings.

C. Control wire for remote control valve operation:
   1. Connection between the automatic irrigation sprinkler controller and the remote control valves shall be made with #14 UF direct burial wire.
   2. Color code each wire with a different color for each valve station. Common to be black.

2.06 BACKFLOW PREVENTER
   A. Backflow preventer shall be as specified on Submittal Drawings.

2.07 CONTROL VALVE BOXES
   A. Ball Valve: Use 10"x10-1/4" round box for all gate valves, Carson Industries #910-12B with green bolt down cover or approved equal. Extension sleeve shall be PVC-6" minimum size.
   B. Remote Control Valve: Use 9-1/2"x16"x11" rectangular box for all electrical control valves, Carson Industries 1419-12B with green bolt down cover or approved equal.

2.08 SPRINKLER HEADS
   A. All sprinkler heads shall be as specified on Submittal Drawings.

2.09 COMMUNICATION CABLE
   A. Shall be as specified in the Electrical Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION
   A. Excavations:
      1. Depths of minimum cover unless otherwise specified.
         a. Pressure main lines - 18" deep.
         b. Pressure main line under paving - 24" deep run in a Schedule 40 PVC sleeve; under train tracks - 5'-6" below base of rail per Engineering Standard ES5001, run in a Schedule 40 PVC sleeve.
c. Non pressure lateral sprinkler lines - 12" deep.

d. Control wires - Below main lines when installed with main line pipe, 18" minimum. Run in a Schedule 40 PVC pipe sleeve under paving. (May share pipe sleeve with main line pipe.)

e. Lateral line under paving - 18" deep.

2. Wherever possible, the main and lateral line may occupy the same trench. Main and lateral lines in the same trench must be spaced a minimum of 6" horizontally apart.

B. Trenching:

1. Trenches shall be dug straight.

2. Trench bottoms shall be at a true gradient providing support to pipe through its entire length and shall be free from rocks, clods, debris and sharp edged objects.

C. Cathodic Protection:

1. Cathodic protection shall be provided in piping systems by installing insulating couplings, flanges, or unions between copper or brass and steel or cast iron pipe. (Any dissimilar metals)

D. Plastic Pipe and Fitting:

1. Sprinkler head and installation shall be as detailed on Submittal Drawings.

2. Due to the nature of plastic pipe and fittings, the Contractor shall exercise care in handling, loading, unloading and storage to avoid damage. The pipe and fittings shall be stored under cover, and shall be transported in vehicle with a bed long enough to allow the length of pipe to lie flat, so as not be subject to undue bending or concentrated external load at any point. Any pipe that has been dented or damaged shall be discarded until such damage has been cut and pipe is rejoined with a coupling.

3. The bottom of the trench in which plastic pipe is installed shall be free from rocks or other sharp edged objects.

4. Welded joint shall be given at least 15 minutes setup curing time before moving or handling. Pipe shall be partially center loaded to prevent arching and slipping under pressure. No water shall be permitted in pipe until a period of at least 24 hours has elapsed for solvent weld setting and curing.

5. Backfilling shall be done when pipe is not in an expanded condition due to heat. Cooling of the pipe can be accomplished by operating the system for a short time before the heat of the day.
6. Long runs of PVC pipe shall be snaked in the trench to allow for contraction.

E. Backflow Preventer

1. All installation shall be per manufacturer's recommendation and per state and local code.

2. Backflow preventer to be located in a planting area in a location to be screened by plant material. Precise location as directed or approved by Engineer.

F. Automatic Controller:

1. Controller shall be mounted securely as per manufacturer's recommendations in an accessible location as directed by the Engineer.

   Controller wires shall be installed in electrical conduit from controller to below finish grade. Controller to be located as indicated on the Submittal Drawings.

2. Electrical wiring shall be installed according to local code. The cost of this electrical connection shall be a part of this Contract.

G. Controller Wire:

1. The control wire shall be buried alongside other pipe in trenches a minimum of 18" deep and bundled and taped at 10' on center.

2. No controller wire splices will be allowed between automatic controller and remote control valve without approval by the Engineer.

3. Control wire splices and connections shall be made with Pen Tite connectors or approved equal.

4. If allowed, all controller wire splices between automatic controller and remote control valves shall be made in a 10"x10-1/4" round box, Carson Industries #910-12B with green bolt down cover or approved equal.

H. Remote Control Valves:

1. Remote control valves shall be installed at sufficient depth to provide not more than 10", nor less than 6", cover from the very top of the valve to finish grade, per Submittal Drawings.

2. Before backfill of automatic valves, packing nuts shall be checked and tightened to prevent leakage.

3. All remote control valves shall be housed in Carson boxes or approved
equal.

I. Backfill of Trenches:

1. Trenches shall be backfilled with excavated dirt after pipe has been installed. Backfill shall be placed in layers; the thickness of the layer shall depend on the nature of the material and the method of compaction used.

2. Compaction shall be such that there will be no settling within the one-year guarantee period. The Contractor shall not place detrimental subsoil in the top 5” of backfill.

3. Water compaction will be permitted.

J. Testing of Irrigation System:

1. The Contractor shall request the presence of the Engineer, at least 48 hours in advance of testing.

2. Test all pressure lines under hydrostatic pressure of 150 pounds per square inch, and prove watertight.

3. Testing of pressure mainlines shall occur prior to installation of electrical control valves.

4. All piping under paved areas shall be tested under hydrostatic pressure of 150 pounds per square inch, and proved watertight, prior to paving.

5. Sustain pressure in lines for not less than two (2) hours. If leaks develop, replace joints and repeat test until entire system is proven watertight.

6. All hydrostatic tests shall be made only in the presence of the Engineer.

No pipe shall be backfilled until it has been inspected, tested and approved in writing.

7. Furnish necessary force pump and all other test equipment.

8. When the sprinkler irrigation system is completed, perform a coverage test in the presence of the Engineer, to determine if the water coverage for planting areas is complete and adequate. Furnish all materials and perform all work required to correct any inadequacies of coverage due to deviations from Submittal Drawings, or where the system has been willfully installed as indicated on the Submittal Drawings when it is obviously inadequate, without bringing this to the attention of the Engineer. This test shall be accomplished before any ground cover is planted.

9. Upon completion of each phase of work, entire system shall be tested and adjusted to meet site requirements.
K. Guarantee:

1. The entire irrigation system shall be guaranteed by the Contractor to give complete and satisfactory service as to material and workmanship for a period of one year from the date of final acceptance of the work by the Engineer.

2. Should any trouble develop within the specified guarantee period which in the opinion of the Engineer, is due to inferior or faulty material and/or workmanship, the trouble shall be corrected, without delay, by the Contractor to the satisfaction of, and at no expense to the Engineer, as part of this Contract.

3. Any and all damage to rain water drains, water supply lines, gas lines and/or other service lines shall be repaired and made good by the Contractor at no extra cost to the Engineer.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Irrigation System will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Irrigation System furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 32 90 00

LANDSCAPING

PART 1 - GENERAL

1.01 SUMMARY

A. Work Include:

Furnish all labor, materials and equipment for installing landscape planting complete as directed and indicated, including but not limited to the following:

1. Site Preparation
2. Fine grading and soil preparation
4. Furnish and planting of plant material as required by the Contractor’s design submittal.
5. Staking and protecting trees and plantings
6. Maintenance of plants and planting for a minimum of 90 calendar days after completion and acceptance of the work
7. Disposal of surplus material, excess dirt and debris off-site, and site clean.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 32 80 00 – Irrigation System

1.02 SUBMITTALS

A. Provide Landscaping design and shop drawings, products data and samples in accordance with Section 01 33 00, Submittal Procedures.

1. Submit a landscaping and landscape Irrigation Sprinkler system design meeting the requirements of the affected city or county Municipal Code. A sample listing of acceptable plants, landscape irrigation equipment, and plant sizes is attached for reference.

2. Submit delivery slips for all soil amendments including but not limited to fertilizer, organic amendments and top mulch.

1.03 DELIVERY, STORAGE AND HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during and after installation.

B. Replacement: In the event of damage, immediately make repairs and
replacements necessary to the satisfaction of the Engineer and at no additional cost to the Authority.

1.04 GUARANTEE AND REPLACEMENT

A. Guarantee plant material, including flatted materials, but less than 15-gallon size, for a period of three months, and plant material 15-gallon size and over for a period of one year from the date of final acceptance of the Project, this date to be established by the inspection and written acceptance at the conclusion of the maintenance period.

B. Replace any plant materials that die-back and lose their form and size as originally specified, even though they have taken root and are growing after the die-back.

C. Within ten days of written notice by the Authority, remove and replace guaranteed plant materials which have failed to meet the requirements of the guarantee. Make replacements to the same specifications as required for the original plants and guarantee as specified for the original guaranteed material.

D. Be responsible for any damage to other work as a result of replacement operations and repair as before at no additional expense.

PART 2 - PRODUCTS

2.01 TREES

A. General: Quality of all plants shall conform to the State of California Grading Code of Nursery Stock #1 Grade, and full sized. They shall be vigorous, of normal growth, free of disease, insects and latent defects.

Pruning shall not be done prior to delivery except by the specific written direction of the Engineer.

Plants shall be subject to inspection and approval or rejection at place of growth and on the project site at any time before or during progress of work for size, variety, conditions, latent defects or injuries. Rejected plants shall be removed from the project site immediately.

Quantities shall be furnished as needed to complete work on Contract Documents.

B. Trees: See plant list on Drawings.

C. Tree Stakes: Shall be 2” diameter x 10’ long new lodge pole pine treated with copper napthenate.

D. Tie: Shall be as detailed per plan, three (3) per double tree stake.

E. Organic Amendment's: Nitrolized wood shavings, Kellogg or approved equal.
F. Commercial Fertilizer Tablets: Agriform 21 gram 20-10-5 Planting Tablets.

G. Commercial Fertilizer: Gro Power as manufactured by Southern California Organic Fertilizer Co., Glendale, CA, (818) 295-6849

PART 3 - EXECUTION

3.01 INSPECTION

A. Plants shall be subject to inspection and acceptance at place of growth or upon delivery to the site, for quality, size and variety. Such acceptance shall not impair the right of inspection and rejection at a later time or during progress of work for size, conditions of ball and roots, and latent defects or injuries. Remove rejected plants from the site immediately. Trees 15-gallon size or larger shall be accepted by the Engineer prior to delivery. Inspections and approvals are also required for the landscape work noted there.

B. Inspection herein specified shall be made by the Engineer. Request inspection in writing, at least two working days in advance of time inspection is required. Inspections and approvals are also required for the landscape work noted there.

C. Inspections and written approvals by the Engineer will be required for the following landscape parts of the work:

1. Verification of all soil conditioning products stockpiled on site prior to installation.

2. Upon completion of grading and soil conditioning prior to planting.

3. When trees are spotted for planting, but before planting, holes are excavated.

4. When planting and other indicated or specified work except the maintenance period has been completed. Acceptance in writing shall establish beginning of the maintenance period.

5. Final inspection at the completion of the maintenance period.

D. Contractor or his authorized representative shall be on the site at the time of each inspection.

3.02 INSTALLATION

A. Sequence of Work: Refer to provisions in Section 01 14 00, Work Restrictions.

B. Soil Preparation and Fertilization:

1. All areas to be planted or seeded shall be cultivated to a uniform depth of
at least six inches and for this entire depth the soil shall be made loose and friable.

2. At time of planting, the top two inches (2") of all areas to be planted shall be free of stones, stumps, roots or other deleterious matter one inch (1") in diameter or larger and shall be free from all wire, plaster or similar objects that would be a hindrance to planting or maintenance.

3. Deliver the fertilizer to the site in sealed bags with the manufacturer's analysis printed on or attached to each bag. Do not apply fertilizer until the total quantity needed for the entire job has been delivered to the site, recorded and accepted by the SCRRA.

4. Rototill the following amendments uniformly to a depth of 6": 3 cubic yards nitrolized shavings per 1,000 square feet and 150 lbs. of Gro-Power per 1,000 square feet. Quantities for bid purposes only. Contractor to install soil preparation per Agronomic Soils Analysis recommendations.

5. Contractor to obtain and submit to SCRRA an Agronomic Soils Analysis of on site soil after final grade is established.

C. Planting:

1. Protect plants from sun, wind and rain at all times before planting.

2. Do not plant trees until construction work in the area has been completed, final grades established, the planting areas properly graded and prepared as herein specified, and the work accepted by the Engineer.

3. Set plants so that when settled they bear the same relation to the finish grade as they bore to the natural grade in the container before being planted.

4. Upon the completion of planting operations and as a requirement just prior to the final inspection, lightly cultivate and neatly rake soil between the plants. Leave basins around the plants unless otherwise directed.

D. Trees:

1. Planting - Stake plant locations and obtain approval from the Engineer before excavating pits, making necessary adjustments as directed.

2. Plants not dimensioned as to precise locations on the drawings shall be scaled from the drawings and the plant placed in the appropriate relationship.

3. Backfill - Shall be 6 parts rock free on site soil, 4 parts nitrolized wood shaving, and 15 lbs. of Gro-Power per cu. yd. of mix.

4. Backfill shall be "machine mixed" at each plant, planter, or container, and
consistency of mix must be reviewed by the SCRRA before planting begins.

5. Agriform 21 gram planting tablets shall be placed 6-8" deep at the side of root ball at the following rates:

- 1 gallon can plants: 1 tablet
- 5 gallon can plants: 3 tablets
- Plants in large tubs or boxes: 2 tablet for each 1/2" of tree trunk diameter (6" above soil level) or for each foot of height or spread of shrubs.

6. For planting, a hole two (2) times the diameter and 6” deeper than the root ball shall be dug for each plant. All materials resulting from excavation of plant holes, other than the existing topsoil, shall be disposed of at the Contractor's expense. Backfill shall be placed in the bottom of each hole to a growing depth at which the plant, when planted, will be 1” above normal growing depth. Backfill is half-way up the root ball, when the hole shall be watered sufficiently to settle the backfill around the root ball. More backfill shall be firmed sufficiently to force air pockets from each hole.

7. No boxed, balled or canned plants shall be planted if the ball is broken or cracked, whether before or during the process of planting. Any trees transplanted by the Contractor that die or have bark, branch or die-back injury shall be replaced with equal trees approved by the Engineer at the Contractor's expense.

### 3.03 MAINTENANCE

A. Apply water, weed, fertilize, care for plants and perform the following plant establishment work:

B. Maintain the entire project for a minimum period of 90 days or until acceptance of Contract, whichever is later, commencing from the time all items of irrigation and landscaping work have been completed to the satisfaction of the Engineer. Start of plant establishment work shall begin only after written review by the Engineer. Periods which the site is not adequately maintained and the Contractor has been notified in writing as such will not be counted as maintenance days and the maintenance period will be extended for a matching number of days.

C. During the entire maintenance period, keep all plants and planted areas well watered and weed free at all times. Remove weeds and undesirable grasses. Care for the entire project so that a neat and clean condition will be presented at all times to the satisfaction of the Engineer.

D. In order to expedite the plant establishment work, maintain a sufficient number of men and adequate equipment to perform the work herein specified, from the time any planting is done until the end of the final maintenance period.
E. The Contractor may be relieved from maintenance work when the maintenance period or plant establishment work has been completed to the satisfaction of the Engineer.

F. Replace damage to planting areas immediately.

1. Depressions caused by vehicles, bicycles or foot traffic, shall be filled with topsoil and leveled. Replant damaged areas.

2. Exterminate gophers and moles and repair damage as noted above.

3. Apply commercial fertilizer 5-3-3 at 30 day intervals (minimum 3 applications) at a rate of 25 lbs. per 1000 square feet. Final applications to be applied 10 days prior to acceptance by the Engineer.

4. Submit written notice requesting final inspection a minimum of seven days prior to anticipated date.

3.04 CLEAN-UP

A. Upon completion of planting work and before final acceptance, remove material, equipment and debris resulting from this work. Broom clean paved areas and leave the site in a neat condition and acceptable to the Engineer.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Landscaping will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

4.02 PAYMENT

A. Landscaping furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 32 91 00

SOIL EROSION, SEDIMENT CONTROL, TOPSOILING AND SEEDING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Soil erosion and sediment control.
   2. Topsoiling and finish grading.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 31 11 00 - Site Clearing.
   3. Section 31 20 00 - Earthwork.
   4. Section 33 42 00 - Culvert and Drainage Pipe.

1.02 REFERENCES

A. Erosion Control Standards: "Standards and Specifications for Soil Erosion and Sediment Control in Developing Areas" by the United States Department of Agriculture (USDA), Soil Conservation Service, College Park, Maryland.


C. ASTM International (ASTM):


1.03 QUALITY ASSURANCE

A. Certifications:
   2. Society of Commercial Seed Technologists – Seed Technologist Certification.
PART 2 - PRODUCTS

2.01 MATERIALS

A. General:
   1. Submittals shall be made in accordance with Division 01 requirements.

B. Certificates:
   1. Material test reports or certifications for all seed mixtures and products intended to be purchased and used for the Project shall be furnished to the Engineer for approval prior to commencing Work under this Specification.

C. Straw Bales: Twine tied.

D. Pipe Riser and Barrel: 16 gage corrugated metal pipe (CMP) of size indicated. Coating and fabrication shall be in accordance with Section 33 42 00.

E. Stone for Stone Filter: 2 inches graded gravel or crushed stone in accordance with Section 32 11 00.

F. Commercial Fertilizer:
   1. Conform to requirements of the California Food and Agricultural Code.
   2. Shall be in pelleted or granular form.
   3. Shall have a guaranteed chemical analysis of 16 percent nitrogen, 20 percent phosphoric acid and 0 percent water soluble potash and shall contain a minimum of 12 percent sulfur or a chemical analysis as required in the plans.

G. Straw shall be derived from wheat, rice or barley.
   1. Contractor must furnish evidence that clearance has been obtained from the County Agricultural Commissioner, as required by law, before straw obtained from outside the county in which it is to be used is delivered to the site of the work.

H. Mulch Fiber shall be produced from natural or recycled (pulp) fiber, such as wood chips or similar wood materials or from newsprint, chipboard, corrugated cardboard or combination of the processed materials, and shall be free of synthetic or plastic materials.
   1. Fiber shall not contain more than 7 percent ash as determined by ASTM D586.
   2. Fiber shall have a water-holding capacity by weight of not less than 100 percent.
3. Fiber shall be of such character that the material will disperse into a uniform slurry when mixed with water.

4. Fiber shall be colored to contrast with the area on which the fiber is to be applied and shall not stain concrete or painted surfaces.

5. pH between 4.3 and 6.0.

I. Grass Seed:

1. Shall be the type as specified in the plans.

2. When not specified in the Plans, Coastal Sage Scrub Mix shall be used per the following table:

<table>
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<tr>
<th>Botanical Name</th>
<th>Common Name</th>
<th>Pounds/Acre</th>
<th>Purity / Germination</th>
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<tbody>
<tr>
<td>Artemisia California</td>
<td>California Sage Brush</td>
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</tr>
<tr>
<td>Encelia California</td>
<td>Bush Sunflower</td>
<td>3</td>
<td>60/40</td>
</tr>
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<td>Eschscholzia California</td>
<td>California Poppy</td>
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<td>75/98</td>
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<tr>
<td>Lotus Scoparius</td>
<td>Deerweed</td>
<td>8</td>
<td>60/90</td>
</tr>
<tr>
<td>Eriogonum fasciculatum</td>
<td>California Buckwheat</td>
<td>8</td>
<td>65/10</td>
</tr>
<tr>
<td>Lasthenia glabrata</td>
<td>Goldfields</td>
<td>2</td>
<td>85/90</td>
</tr>
<tr>
<td>Lupinus Succulentus</td>
<td>Arroyo Lupine</td>
<td>4</td>
<td>85/90</td>
</tr>
<tr>
<td>Eriophyllum confertiforum</td>
<td>Golden Yarrow</td>
<td>3</td>
<td>60/30</td>
</tr>
<tr>
<td>Salvia apiana</td>
<td>White Sage</td>
<td>4</td>
<td>50/70</td>
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<tr>
<td>Sisyrinchium bellum</td>
<td>Blue-Eyed Grass</td>
<td>1</td>
<td>75/95</td>
</tr>
<tr>
<td>Diplacus longiflorus</td>
<td>Monkey Flower</td>
<td>2</td>
<td>55/2</td>
</tr>
<tr>
<td>Salvia mellifera</td>
<td>Black Sage</td>
<td>4</td>
<td>50/70</td>
</tr>
<tr>
<td>Stipa pulchra</td>
<td>Purple Needlegrass</td>
<td>2</td>
<td>70/60</td>
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<td>Bromus arizonicus</td>
<td>Cucamonga Brome</td>
<td>5</td>
<td>95/80</td>
</tr>
<tr>
<td>Melica california</td>
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<td>90/60</td>
</tr>
<tr>
<td><strong>TOTAL POUNDS PER ACRE</strong></td>
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<td><strong>55</strong></td>
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*Slurry Mix*

<table>
<thead>
<tr>
<th>Fiber</th>
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</thead>
<tbody>
<tr>
<td>Organic Soil Stabilant (Tackifier)</td>
<td>140</td>
</tr>
</tbody>
</table>
3. Seed (per seed type) shall be a minimum of 50 percent Pure Live Seed (PLS) content. PLS content is defined as the product of 1) the percentage of tested purity and 2) the percentage of tested germination of the specified seed (PLS content = % purity x % germination = 50%) unless otherwise stated. The Engineer may reduce the PLS content if the specified minimum is not available.

4. All legumes shall be inoculated with viable bacteria compatible for use with that species of seed. Contractor must furnish written statement of inoculation. The application rate for seed shall be the weight exclusive of inoculating Materials.

5. Inoculated seed shall be sown within 20 days of inoculation or shall be reinoculated. The inoculant shall be added at the rate of five times the amount recommended in the inoculant package.

6. Signed copies of vendor’s statement for the seed mixture shall be supplied the Engineer for approval prior to using the seed.
   a. State botanical and common name.
   b. Place of Origin.
   c. Strain.
   d. Percentage of purity, germination.
   e. Amount of PLS per bag.

7. Each container of seed will be labeled in accordance with Federal and State Seed Laws with certification that the seed equals or exceeds requirements in these Specifications or as shown on the Plans.

J. Stabilizing Emulsion:

1. Organic Soil Stabilant shall be registered with and licensed by the State of California, Department of Food and Agriculture, as an “auxiliary soil chemical.”

2. Shall be a concentrated liquid chemical that forms a plastic film upon drying and allows water and air to penetrate.

K. Water shall be free of substances harmful to growth. Provide water from a source approved prior to use.

L. Erosion Control Blanket:

1. General:
   a. Plans shall specify if the erosion control blanket will have seeds mixed with material and the type and rate of seeds to be placed in the mat.
2. Straw Mat/Blanket:
   a. The blanket shall be machine-produced mat consisting of 70 percent agricultural straw and 30 percent coconut fiber.
   b. The straw and coconut fiber shall be uniformly distributed throughout the mat to a loose thickness of about 1/2 inches, plus or minus 1/8 inches.
   c. The blanket shall be of consistent thickness with its straw and coconut fiber evenly distributed over the entire area of the mat. The blanket shall be covered on the top side with polypropylene netting having an approximate 3/4 inches x 3/4 inches mesh containing ultraviolet additives to resist breakdown for at least 90 days, and on the bottom with a polypropylene netting with an approximate 1/2 inches by 1/2 inches mesh. The blanket shall be sewn together with biodegradable thread.
   d. Average dry weight shall be at least 0.70 lbs/sq. yd.
   e. Minimum width shall be 6 feet.

3. Jute Matting:
   a. Uniform open plain weave of unbleached, single jute yarn treated with a fire retardant chemical.
   b. Yarn shall be of loosely twisted construction and not vary in thickness by more than 1/2 of its nominal diameter.
   c. Furnished in rolled strips about 150 feet long, average width about 48 inches, plus or minus one (1) inch.
   d. Average weight about 0.92 lbs/sq. yd., plus or minus 5 percent.

4. Excelsior Blanket:
   a. Machine produced mat of wood excelsior with 80 percent of fibers being at least 6 IN long.
   b. Wood from which excelsior is cut shall be properly cured to achieve adequately curled and barbed fibers.
   c. Blanket shall be of consistent thickness, with even distribution of fibers.
   d. The blanket shall be covered on the top side with a 90-day biodegradable extruded plastic mesh netting, entwined with the blanket.
   e. Minimum weight of blanket shall be 0.8 lbs/sq. yd., plus or minus 5 percent.
f. Minimum width of blanket shall be 24 inches, with rolls being about 150 feet long.

g. Blanket shall not flame or smolder for more than a distance of 12 inches from a spot where a lighted cigarette is placed on the surface of the blanket.

5. Erosion control anchors shall be as recommended by the manufacturer.

M. Wattles and Coir Logs:

1. Wattles shall consist of cylinders of biodegradable plant material such as straw, coir, compost, or wood shavings encased within biodegradable or photodegradable netting.
   a. Minimum 5 inches dia.
   b. Encasing material clean, evenly woven, free of encrusted concrete or other contaminating materials.
   c. Encasing material shall be free from cuts, tears, or weak places and shall have a life-span greater than 6 months.
   d. Fill shall be coarse compost material.

2. Coir Logs shall be 100 percent durable coconut (coir) fiber uniformly compacted with an outer netting.
   a. Log Segments shall have a maximum length of 20 feet and a diameter as shown in the plans.
   b. Logs shall have a density of 7 lbs/cu. feet or greater
   c. Logs shall be manufactured with a woven wrapping netting made of bristle coir twine with minimum strength of 80 lbs tensile strength. Netting shall have nominal 2 inches x 2 inches openings.
   d. Wood stakes as shown in the plans, shall have a notch to secure rope ties of 1/4 inches dia. commercially available hemp rope.

N. Topsoil:

1. Original surface soil typical of the area.

2. Existing topsoil stockpiled under Section 31 11 00.

3. Capable of supporting native plant growth.

O. Tolerances:

1. Finish Grading Tolerance: 0.1 feet plus/minus from required elevations
P. Silt Fence:

1. Posts:
   a. Posts must be wood or metal.
   b. Wood posts must be:
      1) At least 2 X 2 inches in size and four (4) feet long.
      2) Untreated fir, redwood, cedar, or pine, cut from sound timber.
      3) Straight and free of loose or unsound knots and other defects that could render the posts unfit for use.
      4) Pointed on the end to be driven into the ground.
   c. Metal posts must:
      1) Be at least 4 FT long.
      2) Be made of steel.
      3) Have a U-shaped, T-shaped, L-shaped, or other cross-sectional shape that can resist failure from lateral loads.
      4) Be pointed on the end to be driven into the ground.
      5) Weigh at least 0.75 lbs/ft.
      6) Have a safety cap attached to the exposed end. The safety cap must be orange or red plastic and must fit snugly onto the metal post.
   d. Do not use metal posts for a temporary large sediment barrier.
   e. Posts for a temporary reinforced silt fence must be at least six (6) feet in length for a Type 1 installation and five (5) feet in length for a Type 2 installation.
   f. Posts used as stakes for a temporary straw-bale barrier must be wood or metal.

2. Silt Fence Fabric:
   a. When tested under the referenced ASTMs, the properties of silt fence fabric must have the values shown in the following table:
### Table 1: Property Test and Values

<table>
<thead>
<tr>
<th>Property</th>
<th>Test</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grab breaking load, lb min, in each</td>
<td>ASTM D 4632</td>
<td>120/120</td>
</tr>
<tr>
<td>Apparent elongation, percent min, in each</td>
<td>ASTM D 4632</td>
<td>15/50</td>
</tr>
<tr>
<td>Water flow rate, gal per minute/sq ft</td>
<td>ASTM D 4491</td>
<td>10–100/100–150</td>
</tr>
<tr>
<td>Permittivity, sec^-1</td>
<td>ASTM D 4491</td>
<td>0.1/1.1</td>
</tr>
<tr>
<td>Apparent opening size, inches max average</td>
<td>ASTM D 4751</td>
<td>0.023/0.023</td>
</tr>
<tr>
<td>Ultraviolet resistance, percent min retained grab breaking load, 500 hrs</td>
<td>ASTM D 4355</td>
<td>70/70</td>
</tr>
</tbody>
</table>

### 3. Fasteners:

a. Steel staples must be a minimum of 11 gage, 6 inches, U-shaped staples with a one (1) inch crown. Provide heavier gage and greater length if required by the site conditions. You may use an alternative attachment device such as a 100 percent biodegradable fastener to install RECP instead of staples.

### Q. Inlet Protection:

1. **Gravel bag berm:**
   a. Gravel-filled bags must:
      1) Be made of geosynthetic gravel-filled bag.
      2) Have inside dimensions from 24 to 32 inches long and from 16 to 20 inches wide.
      3) Have a bound opening to keep gravel. The opening must be sewn with yarn, bound with wire, or secured with a closure device.
      4) Weigh from 30 to 50 lbs when filled with gravel.
   b. Gravel for gravel-filled bags must be from 3/8 to 3/4 inch DIA and must be clean and free of clay balls, organic matter, and other deleterious materials.

2. **Fiber Rolls:**
   a. Fiber roll must have a minimum functional longevity of 1 year and comply with the following requirements:
1) Type A fiber roll must be fabricated from an erosion control blanket rolled along its width. Secure with natural fiber twine at 6 feet intervals, and 6 inch from each end. Fiber roll size must comply with either one of the following:

a) 8 to 10 inch DIA, 10 to 20 feet long, and at least 0.5 lbs./ft.

b) 10 to 12 inch DIA, at least 10 feet long, and at least 2 lbs./ft.

2) Type B fiber roll must be a premanufactured roll filled with rice or wheat straw, wood excelsior, or coconut fiber. Rolls must be covered with biodegradable jute, sisal, or coir fiber netting secured tightly at each end. Fiber roll size must comply with either one of the following:

a) 8 to 10 inch DIA, 10 to 20 feet long, and at least 1.1 lbs./ft.

b) 10 to 12 inch DIA, at least 10 feet long, and at least 3 lbs./ft.

3. Check Dams:

a. Gravel bag berm:

1) Gravel-filled bags must:

a) Be made of geosynthetic gravel-filled bag.

b) Have inside dimensions from 24 to 32 inch long and from 16 to 20 inch wide.

c) Have a bound opening to keep gravel. The opening must be sewn with yarn, bound with wire, or secured with a closure device.

d) Weigh from 30 to 50 lbs. when filled with gravel.

2) Gravel for gravel-filled bags must be from 3/8 to 3/4 inch in diameter and must be clean and free of clay balls, organic matter, and other deleterious materials.
1. Install perimeter dikes and swales.

2. Excavate and shape sediment basins and traps.

3. Construct pipe spillways and install stone filter where required.

4. Machine compact all berms, dikes and embankments for basins and traps.

5. Install straw bales where indicated.
   a. Provide two stakes per bale.
   b. First stake angled toward previously installed bale to keep ends tight against each other.

6. Install wattles and coir logs where indicated or as Engineer directs, staking as required by the Plans

B. Construct sediment traps where indicated on Plans during rough grading as grading progresses.

C. Temporarily seed basin slopes and topsoil stockpiles:
   1. Rate: 1/2 lb/1000 sf.
   2. Reseed as required until good stand of grass is achieved.

3.02 DURING CONSTRUCTION PERIOD

A. Maintain Basins, Dikes, Traps, Stone Filters, Straw Bales:
   1. Inspect regularly especially after rainstorms.
   2. Repair or replace damaged or missing items.

B. After rough grading, sow or hydroseed temporary grass cover over all exposed earth areas not draining into sediment basin or trap.

C. Construct inlets as soon as possible.
   1. Excavate and tightly secure straw bales completely around inlets as detailed on Plans.

D. Provide necessary swales and dikes to direct all water towards and into sediment basins and traps.

E. Do not disturb existing vegetation (grass and trees).

F. Excavate sediment out of basins and traps when capacity has been reduced by 50 percent.
1. Remove sediment from behind bales to prevent overtopping.

G. Topsoil and Fine Grade Slopes and Swales or other project areas:

1. Seed and mulch as soon as areas become ready.

3.03 NEAR COMPLETION OF CONSTRUCTION

A. Verify rough grading, finish grading and compaction are complete and accepted by Engineer.

B. Eliminate basins, dikes, traps, and other features that may cause ponding water.

C. Loosen top surface to a depth of 2 inches, removing all stones and debris over 2 inches in any dimension.

D. Spread topsoil from stockpiles or approved sources to compacted depth of 4 inches or as indicated in the Plans.

E. Provide finished surface free of stones, sticks and other material 1 inch or more in any dimension.

1. Provide finished surface smooth and true to required grades.

2. Remove all rivulets and gullies.

F. Fine grade all remaining earth areas, loosen top surface as preparation for seeding and mulching.

G. Spread and mix mulch and fertilizer in accordance with these Specifications or as required in the plans during top surface preparation for seeding and mulching.

H. Do not seed until prepared topsoil has been approved by the Engineer

1. Notify Engineer at least 24 hours before beginning any seeding operations.

3.04 SEEDING

A. General:

1. Do not seed during windy weather or excessively wet or frozen ground conditions.

2. When drought or other unsatisfactory conditions prevail, work shall be stopped when directed.

3. Upon completion of Project, a final check of total quantities of seed used will be made against total area seeded. If minimum rates of application have not been met, Contractor must be required to distribute additional quantities to make up minimum application specified.
B. Hydro Seeding:

1. Prior to seeding, areas to be planted by this method shall be moistened to a depth of 6 IN but shall not be surface wet at the time of application.

2. Proportion and seed mix may be changed by the Engineer to meet field conditions.

3. Mixing of hydro seeding Materials shall be performed in a thoroughly clean tank with a built-in, continuous agitation system, which will apply the slurry to the slopes at a continuous and uniform rate.

4. A dispensing agent may be added provided the Contractor furnishes evidence that the additive is not harmful to the mixture.

5. The seed shall be the last item added to the slurry. Slurry shall be applied within 30 minutes after seed has been added.
   a. Mixture shall be such that an absorbent, porous mat will be formed.

6. The slurry planted areas shall be kept moist during the germination period, but puddling shall be avoided.

7. Any Materials considered harmful, as determined by the Engineer, shall not be used.

C. Power-Drawn Drills or Seeders:

1. Equipment must be certified by Contractor to place seed at the required rates in these Specifications or as shown on the Plans.

2. Method may be used for slopes flatter than 3 horizontal to 1 vertical.

3. Drills or seeders shall be run at right angles to the direction of slope.

4. Engineer will approve use of method.

D. Hand Methods:

1. Use where above methods are not practical as determined by the Engineer.

2. Method must show ability to spread seeds evenly at rates required by these Specifications or the Plans in the areas other methods not practical.
3.05 STRAW MAT/BLANKET

A. Prior to seeding and until placing the blanket, the area to be covered shall be relatively free of all rocks or clods over 1 inch in diameter and all sticks or other foreign material that will prevent the close contact of the blanket with the soil. The area shall be smooth and free of ruts or other depressions.

B. The blanket shall be installed as recommended by the manufacturer.

C. The straw mat/blanket shall be placed within 24 hours after seeding operations have been completed.
   1. If straw mat/blanket contains the seeds, install as soon as practicable after final topsoil preparation has been completed and accepted by the Engineer.

D. Installing Mat or Blanket:
   1. The blanket shall be laid out flat, even, and smooth without stretching or crimping the material.
   2. The blanket shall be applied with the length running parallel to the flow of water.
   3. The blanket edges shall be tightly butted together.
   4. Staples shall be spaced not more than three feet apart in 3 rows for each strip, with a row along each edge and one row alternately spaced in the middle. All ends of the mesh shall be secured by staples spaced six inches apart across the width.
   5. Immediately after the straw mat/blanket has been placed and stapled, the area covered shall be sprinkled and rolled with a light roller of sufficient weight to press the blanket into the surface of the soil.

E. Silt Fence:
   1. Construct a temporary silt fence with silt fence fabric, posts, and fasteners assembled at the job site or with prefabricated silt fence.
   2. If prefabricated silt fence is used, attach the fabric to the posts by inserting the posts into the sewn pockets. If assembled at the job site:
      a. Fasten the fabric to the posts with staples or nails if wood posts are used.
      b. Fasten the fabric to the posts with tie wires or locking plastic fasteners if steel posts are used.
      c. Space the fasteners not more than eight (8) inch apart.
3. Place temporary silt fence parallel with the slope contour. For any 50 feet section of temporary silt fence, do not allow the base elevation of the fence to vary by more than 1/3 of the height of the fence above the ground.

4. Install a temporary silt fence as follows:
   a. Place the bottom of the fabric in a six (6) inch deep trench.
   b. Secure it with the posts placed on the downhill side of the fabric.
   c. Backfill the trench with soil and compact by hand or mechanical methods to secure the fabric in the trench.

5. Connect sections of a temporary silt fence as follows:
   a. Join separate sections of the silt fence to form reaches not more than 500 feet long. Each section must be a continuous run from end-to-end or from an end to an opening, including joined panels.
   b. Secure the end posts of each section by wrapping the tops of the posts with at least 2 wraps of 16 gage tie wire.

6. You may install the silt fence by mechanically pushing the silt fence fabric vertically into the soil. Mechanically installed fabric must not slip out of the soil or allow sediment to pass under the fabric.

F. Inlet Protection:

1. Provide temporary drainage inlet protection around drainage inlets as changing conditions require. Drainage inlet protection must be Type 1, Type 2, Type 3A, Type 3B, Type 4A, Type 4B, Type 5, Type 6A, Type 6B, or a combination, as appropriate for conditions around the drainage inlet.

2. For drainage inlet protection at drainage inlets in paved and unpaved areas:
   a. Prevent runoff ponds from encroaching onto the traveled way or overtopping the curb or dike. Use a linear sediment barrier to redirect runoff and control ponding.
   b. Clear the area around each drainage inlet of obstructions, including rocks, clods, and debris greater than one (1) inch DIA, before installing the drainage inlet protection.
   c. Install the linear sediment barrier upslope of the existing drainage inlet and parallel with the curb, dike, or flow line to prevent sediment from entering the drainage inlet.
3. If gravel-filled bags are used for Type 3A and Type 3B temporary drainage inlet protection, place the gravel-filled bags end-to-end to eliminate gaps. Stack the bags so that the upper row overlaps joints in the lower row. Arrange the bags to create a spillway by removing 1 or more gravel-filled bags from the upper layer.

4. Place fiber rolls over the erosion control blanket for Type 4A temporary drainage inlet protection.

5. If a foam barrier is used for Type 4B temporary drainage inlet protection, secure the barrier to the pavement at the angle and spacing shown. Place the barrier to provide a tight joint with the curb or dike. Cut the cover fabric or jacket to ensure a tight fit.

6. If a rigid sediment barrier is used for Type 6A or Type 6B temporary drainage inlet protection at a grated catch basin without a curb inlet, place the barrier using a gasket to prevent runoff from flowing under the barrier. Secure the barrier to the pavement with nails and adhesive, gravel-filled bags, or a combination.

7. Install a sediment filter bag for Type 5 temporary drainage inlet protection as follows:
   a. Remove the drainage inlet grate.
   b. Place the sediment filter bag in the opening.
   c. Replace the grate to secure the sediment filter bag in place.

8. AUTHORITY does not pay for relocation of temporary drainage inlet protection during the course of work.

G. Fiber Rolls:

1. Before installing fiber roll remove obstructions from the ground, including rocks, clods, and debris greater than one (1) inch DIA.

2. Install fiber roll approximately parallel to the slope contour. For any 20 feet section of fiber roll, prevent the fiber roll from varying more than five (5) percent from level. Install fiber roll on slopes at the following spacing unless shown otherwise:
   a. 10 feet apart for slopes steeper than 2:1 (horizontal:vertical).
   b. 15 feet apart for slopes from 2:1 to 4:1 (horizontal:vertical).
   c. 20 feet apart for slopes from 4:1 to 10:1 (horizontal:vertical).
   d. 50 feet apart for slopes flatter than 10:1 (horizontal:vertical).

3. Type 1 fiber roll installation consists of placing and fastening as follows:
a. Place in a furrow that is from two (2) to four (4) inch deep.

b. Fasten with wood stakes every 4 feet along the length of the fiber roll.

c. Fasten the ends of the fiber roll by placing a stake 6 IN from the end of the roll.

d. Drive the stakes into the soil so that the top of the stake is less than two (2) inch above the top of the fiber roll.

4. Type 2 fiber roll installation consists of placing and fastening as follows:

a. Fasten with notched wood stakes and rope.

b. Drive stakes into the soil until the notch is even with the top of the fiber roll.

c. Lace the rope between stakes and over the fiber roll. Knot the rope at each stake.

d. Tighten the fiber roll to the surface of the slope by driving the stakes further into the soil.

5. Maintain fiber roll in a manner that provides sediment holding capacity and reduces runoff velocities as follows:

a. Remove sediment from behind the fiber roll when sediment is 1/3 of fiber roll height above ground.

b. Repair or adjust the fiber roll when rills or other evidence of concentrated runoff occur beneath the fiber roll.

c. Repair or replace the fiber roll when they become split, torn, or unraveled.

d. Add stakes when the fiber roll slumps or sags.

e. Replace broken or split wood stakes.

f. Remove sediment deposits, trash, and debris from fiber roll as needed or when ordered. If removed sediment is deposited within project limits, it must be stabilized and not exposed to erosion by wind or water.

H. Check Dams:

1. Before placing a temporary check dam, remove obstructions, including rocks, clods, and debris greater than one (1) inch DIA from the ground.

2. If a temporary check dam is to be placed in the same area as an erosion control blanket, install the blanket before placing the dam.
3. A temporary check dam must be:
   a. Placed approximately perpendicular to the centerline of the ditch or drainage line.
   b. Installed with sufficient spillway depth to prevent flanking of concentrated flow around the ends of the check dam.
   c. Type 2 if the ditch is lined with concrete or HMA.
   d. Type 1 or Type 2 if the ditch is unlined.

4. For a Type 1 temporary check dam:
   a. Secure the fiber rolls with rope and notched wood stakes as shown.
   b. Drive the stakes into the soil until the notch is even with the top of the fiber roll.
   c. Lace rope between the stakes and over the fiber roll. Knot the rope at each stake.
   d. Tighten by driving the stakes further into the soil and forcing the fiber roll against the surface of the ditch or drainage line.

5. Place a Type 2 temporary check dam as a single layer of gravel-filled bags, placed end-to-end to eliminate gaps. If you need to increase the height of the dam, add more layers of gravel-filled bags. Stack the bags in the upper row to overlap the joints in the lower row. Stabilize the rows by adding more rows of bags in the lower layers.

3.06 ACCEPTANCE

A. Upon completion of the soil erosion and sediment control obtain Engineer's written acceptance of the work.

B. Upon completion of the topsoil and finish grading, obtain Engineer's written acceptance of the work.

C. Upon completion of the seeding, obtain Engineer's written acceptance of the work.
PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Soil Erosion and Sediment Control will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

B. Topsoil and Finish Grading will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

C. Seeding will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.

D. The required areas of soil erosion and sediment control topsoil and finish grading, and seeding as measured by the Engineer and shown on the Contract Plans shall be used for information purposes only.

4.02 PAYMENT

A. Soil Erosion and Sediment Control furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

B. Topsoil and Finish Grading furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

C. Seeding furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.
D. Full compensation for temporarily placing topsoil along the top of the slopes and later spreading the topsoil over the prepared slopes shall be considered as included in the Contract price.

E. Full compensation for removing and disposing of rocks and debris from embankments constructed as part of the work shall be considered as included in the Contract prices and no additional compensation will be allowed therefore.

END OF SECTION
SECTION 33 05 23

STEEL CASING

PART 1 - GENERAL

1.01 SUMMARY

A. The Work involves furnishing all labor, materials, transportation, and equipment necessary and incidental to installing steel casing up to six (6) feet diameter.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 31 20 00 - Earthwork.
   3. Section 31 50 00 - Excavation Support.
   4. Section SS 33 05 23 – Steel Casing (material requirements)
   5. Section 34 11 26 - Ballast.
   6. Section 34 72 00 - Trackwork.

1.02 REFERENCES


B. SCRRRA Engineering Standard Drawings: Particularly, but not limited to ES5001 and ES5002.

C. SCRRRA Standard Specifications Section SS 33 05 23 for material requirements.

1.03 SYSTEM DESCRIPTION

A. Unless otherwise noted in the Contract Documents or as approved in advance by the Engineer, the Contractor must use the following design criteria:
   1. The depth of cover from base of rail to top of casing shall be 5 feet – 6 inches minimum or equal to the outer diameter of the casing, whichever is greater.

   2. The depth of cover from the flow line of the right-of-way ditch to the top of casing shall be at least four (4) feet for non-flammable substances in the carrier pipe and five (5) feet for flammable or hazardous substances in the carrier pipe.
3. Jacking and receiving pits shall be at least 25 feet clear from the nearest track centerline.

1.04 SUBMITTALS

A. Submit under provisions of Division 01, and the following information:

1. Jacking and Boring Plan and Procedures:
   a. Indicate locations of jacking and receiving pits relative to the track.
   b. Refer to Section 31 50 00 for related submittals for support of pit excavations.
   c. Describe method of jacking and boring including method of grouting annular space between casing and excavated soil.
   d. For directional boring/drilling, submit complete specifications for the machine to be used including:
      1) Operating and maximum pressures of liquid at the drilling head.
      2) Water volume.
      3) Type of reamer or cutting tool, size of holes/nozzles on the head, and method of head control.

B. Fourteen (14) days prior to initiating jacking or boring operations, submit an emergency remediation plan for approval by the Engineer.

1. This plan shall identify methods to cut and remove rock, concrete or timber encountered at the boring face and methods to temporarily bulkhead the face.

2. Contractor must have the resources to execute this plan immediately available before this Work is started.

PART 2 - PRODUCTS

2.01 STEEL CASING

A. The steel casing shall be new and conform to SCRRRA Engineering Standard ES5001 AND ES5002.

B. Specified minimum yield strength (SMYS) of steel shall be at least 35,000 psi.

C. Casing under track shall be designed for Cooper E-80 loading in accordance with AREMA.
1. Minimum thickness shall be in accordance with SCRRA ES5001 or ES5002 as applicable. For those diameters not specified in SCRRA Engineering Standards use AREMA Volume 1, Chapter 1, Part 5; Table 1-5-1 for carrier pipes conveying liquid flammable or highly volatile substances and Table 1-5-5 for other applications.

PART 3 - EXECUTION

3.01 GENERAL

A. Refer to Section 31 20 00 for general excavation requirements including locating utilities.

1. It shall be the Contractor’s responsibility to verify the actual locations (horizontal and vertical) of all utilities prior to beginning Work.

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

3.02 HANDLING OF MATERIAL

A. Casing and ancillary items shall be handled in such a manner as not to damage the Material.

1. Damage to the casing, lining, or coating, if any, shall be repaired to the satisfaction of the Engineer or replaced at no additional cost to SCRRA.

B. Casing shall not be dropped to or dragged over the ground, but shall be handled with rolling slings on skids or with cranes.

C. Bent or otherwise damaged casing or ancillary items shall not be used.

3.03 EXCAVATION

A. Excavation for jacking and receiving pits shall be in accordance with Section 31 20 00 and Section 31 50 00.

3.04 JACKING AND BORING; JACKING AND TUNNELING

A. The jacking and boring method consists of pushing the casing into the earth with a boring auger rotating inside the casing, which removes the spoil.

B. The jacking and tunneling method consists of pushing the casing into the earth with jacks and excavation being performed by worker(s) using handheld tools from within the jacking shield at the head of the casing.

C. Neither Jacking and boring nor jacking and tunneling shall be used in sandy, loose, or otherwise unstable soils or where boulders are anticipated.
D. Jacking and boring:
   1. The front of the pipe shall be provided with mechanical arrangements or devices that prevent the auger from leading the casing so that no unsupported excavation is ahead of the casing.

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

F. The annular space between the casing and the soil shall be grouted.
   1. Such grout shall contain at least 8 sacks of cement per cubic yard of material.

G. Should the operation be abandoned before completion, the annular space between the casing and excavated soil shall be grouted as specified above.
   1. In addition, the complete inside of the casing shall be grouted.
   2. Such grout shall contain at least 2 sacks of cement per cubic yard of material.

H. The hole diameter resulting from bored or tunneled installations shall not exceed the outside diameter of the casing by more than 1.5 inches for casings of less than 12 inches in outside diameter and by 2 inches for casings of greater than 12 inches in outside diameter.

I. Operations shall be stopped for the passage of trains.
   1. The Contractor must employ methods to prevent loss of the excavation face as approved in advance by the Engineer.

J. Operations shall be stopped if ground displacement is detected.
   1. The Contractor must employ the emergency remediation plan approved by the Engineer before resuming operations.
   2. The Contractor is liable for all damage resulting from ground displacement.
   3. Should the track displace, corrective action will be taken by SCRRA forces or shall be taken by the Contractor as approved by the Engineer.
   4. SCRRA costs for such corrective action shall be deducted from the payment due to the Contractor under this Contract.

K. Unless otherwise indicated in the Contract Documents or, as approved in advance by the Engineer, casing installation under track shall be progressed on a continuous basis without stoppage (except for adding casing sections) until the leading edge of the pipe has reached the receiving pit.
L. For casings with drainage culvert carrier pipes, the annular space between the casing and the carrier pipe shall be grouted.

1. Such grout shall contain at least 8 sacks of cement per cubic yard of Material.

M. For casings with carrier pipes that are other than drain culvert pipes, the annular space between the casing and carrier pipe at the casing ends shall be sealed with a concrete bulkhead with a thickness equal to annular space or 6 IN which ever is greater.

N. Provide vents if so indicated in the Contract Documents.

3.05 DIRECTIONAL BORING/DRILLING

A. This method consists of utilizing specialized drilling equipment and boring a small diameter pilot hole along the desired horizontal and vertical alignment, using a mechanical cutting head with high-pressure bentonite slurry to remove the cuttings.

1. Bore pits at either end of the Installation are not necessarily required with this method.

2. The drill string is advanced with the bentonite slurry pumped through the drill string to the cutting head and then forced back along the drill string, carrying the cuttings back to the surface for removal.

3. After the cutting head reaches the far side of the crossing, it is removed and a reamer (with a diameter wider than the cutting head) is attached to the lead end of the drill string.

4. The casing is attached to the reamer and the casing is then pulled back into its final position.

B. Methods that excavate the soil by means of jetting of fluid or slurry are not allowed.

C. Directional boring/drilling may be used for casings 12 inches or less in diameter.

D. Slurry shall be bentonite slurry.

E. Slurry use shall be kept to a minimum and shall only be used for head lubrication or spoils return.

1. The Contractor must calculate anticipated slurry use and shall monitor actual slurry use during the boring operation in order to determine the slurry loss into the surrounding soil.

F. The bentonite slurry shall seal the annular space between the casing and the excavated soil with a minimum return of 95 percent.
G. Bore stems or cutting tools that become immovable under the track shall be abandoned in place.

H. Should the operation be abandoned before completion, the complete inside of the casing shall be grouted.
   1. Such grout shall contain at least 2 sacks of cement per cubic yard of Material.

I. Operations shall be stopped if ground displacement is detected.
   1. The Contractor must develop a remediation plan that is approved by the Engineer before resuming operations.
   2. The Contractor is liable for all damage resulting from ground displacement.
   3. Should the track displace, corrective action will be taken by SCRRA forces or shall be taken by the Contractor as approved by the Engineer.
   4. The SCRRA costs for such corrective action shall be deducted from the payment due to the Contractor under this contract.

J. Operations shall be stopped if slurry is observed to be escaping into the track ballast or right of way ditches.
   1. Track ballast contaminated by slurry shall be removed, replaced with new ballast and tamped per Section 34 72 00 and Section 34 11 26 at the expense of the Contractor.

3.06 CASING JOINTS

A. Casing joints shall be watertight.

3.07 STEEL CASING BULKHEAD

A. Steel casing bulkhead as called out in the Contract Documents shall be installed in locations as identified in the Contract Documents and as per the details as shown in the Contract Documents.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Steel casing will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved schedule of values, as applicable, as derived from the Plans will be used as the basis for this measurement.
B. Steel casing bulkhead is incidental to the steel casing work and no separate measurement will be made.

4.02 PAYMENT

A. Steel casing furnished and completed in accordance with the Contract Documents will be paid for at the Contract Unit Price, as listed on the Schedule of Quantities and Prices. This price shall include full compensation for furnishing all labor, Materials, tools, equipment, supplies, supervision, and incidentals, and doing all work, as shown on the Plans, and as specified in these Specifications, and as directed by the Engineer.

END OF SECTION
SECTION 33 42 00

CULVERT AND DRAINAGE PIPE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Culverts.
   2. Storm drainage systems.
   3. Storm drainage pipe.
   4. Storm Drain Cleanouts.
   5. Concrete Collars.
   6. Brick and Mortar Plugs
   7. Headwalls
   8. Concrete Caps
   9. Inlets, headwalls, flumes and flared end sections.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 31 11 00 - Site Clearing.
   3. Section 31 11 50 - Demolition, Cutting and Patching.
   4. Section 31 20 00 - Earthwork.
   5. Section 31 50 00 – Excavation Support
   6. Section 33 05 23 - Steel Casing.
   7. Section 34 11 27 - Sub-Ballast and Aggregate Base.
   8. Section 34 80 32 - Adhered Elastomeric Waterproofing for Railroad Bridges.
   9. Section 03 31 00 - Structural Concrete.
10. Section 34 80 43 - Precast and Prestressed Concrete for Railroad Bridges.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
1. M274, Steel Sheet, Aluminum Coated (Type 2), for corrugated steel pipe.
2. M252, Corrugated Polyethylene Drainage Pipe.
3. M294, Corrugated Polyethylene Pipe 1 to 5 feet Diameter.

B. ASTM International (ASTM):
1. A31, Standard Specifications for Steel, Rivets and Bars for Rivets, Pressure Vessels.
3. A164, Coating.
4. A760, Corrugated Steel Pipe, Metallic Coated for Sewers and Drains.
5. A761, Corrugated Steel Structural Plate, Zinc-Coated, for Field –Bolted Pipe, Pipe-Arches, and Arches.

C. AREMA Manual for Railway Engineering
1. Chapter 1, Part 4, Section 4.3 Specifications for Prefabricated Corrugated Steel Pipe and Pipe Arches for Culverts, Strom Drains, and Underdrains.

3. Chapter 1 Part 4, Section 4.6, Specifications for Corrugated Structural Steel Plate Pipe, Pipe-Arches and Arches.

4. Chapter 8, Part 10, Reinforced Concrete Culvert Pipe.

5. Chapter 8, Part 16, Design and Construction of Reinforced Concrete Box Culverts.


F. SCRRA Engineering Standards:
   1. ES5001, ES6340, and ES6301 through ES6310.


1.02 SUBMITTALS

A. General:
   1. Submittals shall be made in accordance with Division 01 requirements.

B. Plans and Procedures:
   1. Layout Plans for approval by the Engineer.
   2. Schedules of work.
   3. Design calculations for culverts not constructed in accordance with SCRRA Engineering Standard Plans.
      1. Calculations to be performed by a Professional Engineer licensed to practice in California.
   4. Details for culverts and drainage structures and joints including Shop Drawings and installation procedures.
   5. Proposed bedding test procedures.

C. Certificates:
   1. Product technical data including:
      1. Acknowledgement that products submitted meet requirements of standards referenced.
2. Certifications:

   1. Crushed Stone Bedding Material meeting gradation requirements of Section 34 11 27.

3. Test reports:

   1. Culvert and Drainage Pipe test reports from the fabricator.

4. Compaction testing in accordance with Section 31 20 00. Submit test results for density and compaction tests of culvert bedding and backfill performed by certified test laboratory hired by the Contactor and approved by the Engineer to perform and report testing.

   1) Test results submittal shall be on a form approved in advance by the Engineer.

   2) Test results shall be organized by culvert or drainage structure.

2. Other tests as required for cast-in-place concrete and precast concrete in accordance with Section 03 31 00 and Section 34 80 43 respectively.

5. Submit all tests and certification in a single coordinated submittal. Partial submittals will not be accepted.

D. Miscellaneous Submittals:

   1. Verification documentation that Contractor requested DigAlert and SCRRRA field location of underground utilities prior to starting any excavation work.

1.03 PROJECT SITE CONDITIONS

A. The Contractor shall barricade open excavations and post with warning lights those excavations occurring on property adjacent to or within public access areas and along tracks in accordance with Section 31 50 00. Operate warning lights during hours from dusk to dawn each day and as otherwise required. Warning lights shall not shine into the eyes of locomotive engineers on oncoming trains.

B. The Contractor shall protect utilities, structures and facilities designated as protect in place from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation and backfill operations in accordance with Section 31 50 00 and Division 01. Damage to utilities designed to remain must be repaired by the Contractor to the satisfaction of the Engineer in accordance with these Specifications or replaced at no cost to the Authority.
C. Contractor shall dewater excavations as necessary to allow placement and compaction of bedding material, placement of culvert or drainage structure and placement and compaction of backfill in accordance with Section 31 20 00.

1.04 ENVIRONMENTAL CONDITIONS

A. The Contractor shall protect against erosion and uncontrolled run-off within and adjacent to right-of-way in accordance with Division 01.

B. The Contractor shall obtain all permits for and legally dispose of all water from water removal operations in accordance with Division 01.

C. Cleanliness, Sweeping and Dust Control:
   1. Contractor shall maintain the construction site in accordance with Division 01.

D. Contractor must provide continuous noise abatement as required.
   1. Prevent disturbances and nuisances to the public, workers and occupants of adjacent premises and surrounding areas in accordance with Division 01.

1.03 REGULATORY REQUIREMENTS

E. The Contractor shall furnish any required Excavation Plans to jurisdictional authorities and obtain permits from the jurisdictional authorities as required. Refer to requirements contained in Division 01.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS OF JOINT SEALING MATERIAL

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable for joint sealing material between sections of precast reinforced concrete pipe or precast reinforce concrete box culverts when water tightness is not specified:
   1. Preformed flexible pipe joint sealing compound:
      1. RAM-NEK.
      2. BIDCO C-56.
      3. Or equal.

B. Submit request for substitution in accordance with Division 01.
2.02 MATERIALS

A. Reinforced Concrete Pipe (RCP):

1. When used for storm drainage pipe or culverts and not placed under the track. If placed under the track, the pipe shall be cased per SCRRA ES5001 or ES5002, whichever governs.

2. Reinforced concrete culvert, storm drain and sewer pipe: RCP Joint Sealer:

   1. Rubber gasket: ASTM C361 when water tight joints indicated in the Plans.

   2. Joint sealing material per Article 2.01 above for other joints of concrete pipe.

3. Flared End Sections:

   1. Shall be as shown in the Plans.

4. Jointing: Same as pipe.

B. Corrugated Metal Pipe (CMP) and Structural Plate Pipe (SPP):

1. CMP and Structural Plate Pipe may be used in all culvert or storm drainage applications.

2. CMP shall be either Class 1, annular rings with riveted seams or Class 2, helical rings with lock seams or welded seams per the AREMA Manual Chapter 1, Part 4, Section 4.3 Specifications for Prefabricated Corrugated Steel Pipe and Pipe Arches for Culverts, Storm Drains, and Underdrains. In addition to these requirements, CMP culverts shall meet the following:

   1. Minimum cover and gage shall be per the SCRRA Engineering Standards.

   2. CMP shall be coated in accordance with AASHTO M274, Steel Sheet, Aluminum Coated (Type 2), for corrugated metal pipe.

   3. CMP over 48 inches dia. shall be fabricated with a 5 percent elongation in the vertical direction.
4. CMP Class 1 Culvert Riveted Seams:

1) CMP Class 1 culverts shall have riveted longitudinal seams with one rivet in each corrugation valley for all pipes 24 inches in diameter and smaller. Longitudinal seams shall be riveted with two rivets in each corrugation valley for all pipes larger than 24 inches. Circumferential seams shall be riveted with two rivets in each corrugation valley for all pipes larger than 24 inches. Circumferential seams shall be riveted with a maximum rivet spacing of 2 inches.

2) CMP Class I culverts shall have all 14 gage pipe with at least 5/16 IN DIA rivets. CMP Class I culverts shall have all 12 gage and thicker pipe with at least 7/16" dia. rivets.

3) All rivets shall be cold driven in a workmanlike manner to completely fill the hole without bending.

4) Rivets shall conform to ASTM A31, Grade A and shall be electroplated in accordance with the Specifications of ASTM A164, Type RS.

5. CMP Class 2 Culvert Seams:

1) Lock Seams shall be either continuous welded in accordance with ASTM A 760 or lock seams in accordance with ASTM A 760 and the AREMA Manual for Railway Engineering, Chapter 1, Part 4.5.3.6.

3. Structural Plate Pipe:

1. Structural Plate Pipe shall meet the requirements of AREMA Manual for Railway Engineering Chapter 1, Part 4.6.

1) Base metal shall be in accordance with ASTM A761.

2) Structural Steel Plates shall be coated in accordance with AASHTO M274, Aluminum Coated (Type 2) for corrugated steel pipe with thickness of coating in accordance with ASTM A761.

3) Thickness shall conform to gage shown in table contained in the SCRRRA Engineering Standards.

4. Jointing and End Finish:

1. Corrugated connecting bands of same base metal, corrugations and finish coating as pipe.

2. Connection bands shall conform to Section 66-1.02D of the Caltrans Standard Specifications.
3. Thickness shall conform to gage shown in Table 2 – Round Corrugated Steel Pipe (CSP) contained on the SCRRA Engineering Standards.

4. CMP Class 2, Helical, Culvert Joints shall be made by rerolling the ends of individual pipe sections at least four corrugations from the pipe end or 14 inches to meet the connection band requirements.

5. CMP Joint Sealer when culvert is under pressure or is used in an irrigation application:
   1. Cold applied asphalt joint compound.
   2. Preformed flexible pipe joint sealing compound.

6. Perforated CMP shall have perforations meeting requirements of ASTM A760 for Class 1 Perforations.

7. Concrete and Reinforcement for Inlets, Headwalls, Flumes and End Sections:
   1. Comply with Section 34 80 32.
   2. Concrete and Reinforcement for Inlets, Headwalls, Flumes and End Sections shall conform to SCRRA Engineering Standards ES6301 through ES6310.

C. Corrugated High-Density Polyethylene Drainage Pipe:
   1. Corrugated High Density Polyethylene Drainage Pipe may be used for under drains or other storm drainage not subject to railroad live loading.
      1. It must be installed in a steel casing meeting requirements of Specification Section 33 05 23 and SCRRA ES5001 if placed under the track.
   2. Pipe and fittings shall be a high-density polyethylene meeting ASTM D3350 minimum cell classification 325420C.
   3. Sizes less than 1 foot dia. shall meet requirements of AASHTO M252, Corrugated Polyethylene Drainage Pipe.
   4. Sizes 1 foot up to 5 feet in diameter shall meet requirements of AASHTO M294, Corrugated Polyethylene Pipe 1 to 5 feet dia...

D. Smooth Steel Pipe:
   1. Smooth Steel Pipe may be used for all culvert or storm drainage applications.
   2. Smooth Steel Pipe shall meet the requirements contained in Specification Section 33 05 23.
E. PVC Pipe:
   1. PVC may be used for under drains and storm drainage applications. When subjected to railroad live loading, Schedule 80 PVC pipe shall be used.
   2. PVC Pipe shall meet the requirements of ASTM D1784, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40 and 80. All fittings shall meet ASTM D2729.
   3. Perforated PVC pipe shall have perforations meeting the requirements of ASTM D1784. Perforations shall be 3/8" dia.

F. Reinforced Concrete Box Culvert (Cast-in-Place or Precast) (RCB):
   1. RCB may be used in all culvert or storm drainage applications.
   2. Design shall be per AREMA Manual for Railway Engineering, Chapter 8, Part 16, Design and Construction of Reinforced Concrete Box Culverts.
   3. Concrete and Reinforcing Steel shall meet the requirements of Section 03 31 00 for Structural Concrete, Section 34 80 43 for precast concrete and Section 03 21 00 for reinforcing Steel.
   4. Concrete Strength, reinforcing steel quantities and other culvert details shall be per SCRRA Engineering Standards ES4700 sheets 1-4.

G. Crushed Stone Bedding Material:
   1. Crushed Stone Bedding Material shall meet the requirements of Sub-ballast contained in Section 34 11 27.

PART 3 - EXECUTION

3.01 PREPARATION

   A. The site including the drainage facilities shall be prepared in accordance with Section 31 11 50 and Section 31 11 00.

   B. It shall be the Contractor's responsibility to verify the actual locations (horizontal and vertical) of all utilities prior to beginning trench excavation. If utilities are to remain in place, provide protection from damage during construction operations.

3.02 HANDLING OF MATERIAL

   A. Pipe, fittings and supplementary items shall be handled in such a manner as not to damage the Material. All dirt and trash shall be removed from the pipe prior to installation. Damage to the pipe, pipe lining or coating, if any, shall be repaired to the satisfaction of the Engineer in accordance with these Specifications or replaced at no additional cost to SCRRA.
1. Repairs to damaged coating on CMP shall be made in accordance with ASTM A780 except the repaired area coating shall be modified for aluminum-zinc coated material.

B. Pipes or structural steel plate materials shall not be dropped to or dragged over the ground, but shall be handled with rolling slings on skids or with cranes.

C. Bent or otherwise damaged pipe Materials shall not be used.

D. Distribute pipe and other Materials along the line of Work and outside the trench as near as practical to the point of placement. Do not deposit site Materials on or against pipe.

E. Protect pipe ends until the pipe is placed in its final position.

3.03 INSTALLATION

A. Foundation Preparation

1. Excavate as necessary, prepare pipe bed pre-rolling and removing any unacceptable soil, place and compact Crushed Stone Bedding Material in accordance with the SCRRA Engineering Standards for CMP, SPP and Smooth Steel Pipe when not using jacking and boring installation methods, and SCRRA Engineering Standards ES4700 for Reinforced Concrete Box Culverts.

   1. Other drainage pipes use bedding material as shown in the Plans.

   2. Refer to SCRRA Standard Specification Section 31 20 00 for additional general excavation requirements.

2. The foundation shall be a smoothed and compacted surface conforming to bottom of pipe grade or camber and will hereafter be referred to as the foundation line. The foundation bed shall be free of boulders, tree stumps, cut-off piling, and other projections. Suitable camber to allow for settlement of pipe due to consolidation of embankment material will be provided when required in accordance with the SCRRA Engineering Standards. Shaping to pipe contour is not required.

3. When acceptable foundation material is present, the width of the foundation line shall be a minimum of 4 feet plus the pipe diameter or pipe-arch span. For multiple pipes the above width shall be increased by the sum of the distances between pipe or pipe-arch centers.

4. Where there is solid rock or other unsuitable material, such as boulders, or unstable material that may deform the pipe during minor settlement, at the foundation line, it will be necessary to provide suitable bedding for pipes. Such work will only be undertaken at the specified direction of the Engineer.
5. The width of excavation and bedding backfill shall be the pipe diameter or pipe-arch span in solid rock and boulders, and in other unsuitable material, the width shall be three pipe diameters or pipe-arch spans for single pipes, and for multiple pipes, this width shall be increased by the distances between pipe or pipe-arch centers.

6. Soft, spongy or otherwise unsuitable material encountered at the established and approved grade shall be removed and backfilled with granular material as directed by the Engineer in accordance with Section 31 20 00. Excavation of unsuitable soils will be made in accordance with the unit price for excavation. Payment for backfilling and compacting with suitable soils will be made at the contract unit price for embankment.

7. The Contractor must by diversion ditches, dikes, or other means, keep the foundations free of water at all times after the work is started, and until the embankment is placed over the pipe. Any channel work necessary to allow free flow through the pipe shall be completed before the embankment is placed. This work is incidental to installation of the culvert or drainage pipe.

B. Install Smooth Steel Pipe, if using jacking and boring method, in accordance with Section 33 05 23.

C. Placing Culvert or Drain Pipe:

1. General:

   1. No pipe shall be laid until it has been inspected and approved. All pipes shall be laid upgrade beginning at the lower end of the line. Pipe shall be laid accurately to line and grade. Ensure that the pipe has a full solid bearing along its entire length. When pipe has been checked for line and grade, the body of the pipe shall be sufficiently backfilled and compacted in accordance with Section 31 20 00 on both sides to hold the pipe firmly in position.

   2. All adjustments to line and grade of the pipe laid on earth foundation shall be done by removal or filling of the bedding under the pipe and not by blocking or wedging.

   3. Where two or more pipes are used, there shall be a minimum of 3 feet, or 1/2 pipe diameter or pipe-arch span, clear distance apart, whichever is greater. Where practicable, in the opinion of the Engineer, a space of 10 feet may be provided between pipes to facilitate the compaction of fill material around the pipes with heavy equipment.

2. Placing CMP:
1. Pipe having riveted seams shall be laid with outside laps of circumferential joints pointing upstream, longitudinal laps on the sides and, when shown in the Project Plans, asphalt paving on the flow line.

2. Pipe sections shall be firmly joined together with connecting bands. All dirt or other foreign materials must be kept out from between pipe and band. Outside connecting bands should be slipped over the end of one section, and the adjoining section brought within 1 inch of the first. Band shall be made to fit snugly and equally on each pipe section and bolted to produce a tight joint. The lower half of two-piece connecting bands for pipe having riveted seams may be furnished already connected to one of the pipe sections, and in such cases the end having the fixed half band shall be placed downstream. Band couplers and ends of pipe under the bands may be lubricated with oil or solvent, which has been approved by the Engineer. Excess asphalt at joints may be removed by an application of heat, if necessary. Where corrugated pipe is to be placed in an irrigation ditch, continuous waterway or spring area, rubber gaskets shall be placed around the first re-rolled corrugation at each end of the pipe before the band is placed to keep the joint watertight.

3. At locations where the existing corrugated pipe is to be extended with new pipe, the joining end of the existing pipe shall be free of breaks, cracks or other defects. If in the judgment of the Engineer the end of the existing corrugated pipe is not suitable for making a proper joint, the Contractor must, as directed by the Engineer, remove or trim the amount of pipe necessary to allow making of an approved joint. Such removal and trimming will be considered incidental to the cost of the pipe and no direct payment will be made therefore.

4. Pipe-arches shall not be strutted.

5. Identification tag, supplied by manufacturer, shall be attached near top of and inside of pipe at upstream end.

6. Field strutting of corrugated pipe:

   1) When the distance from base of rail to the top of pipe will be less than the dimensions given in Table 1, corrugated pipes must be field strutted by the Contractor using Contractor supplied material.

<table>
<thead>
<tr>
<th>CMP Pipe Diameter - Inches</th>
<th>Base of Tie to Top of Pipe - Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>3.5</td>
</tr>
<tr>
<td>54 to 66, incl.</td>
<td>4.0</td>
</tr>
<tr>
<td>72 to 96, incl.</td>
<td>4.5</td>
</tr>
<tr>
<td>102 to 108, incl.</td>
<td>5.0</td>
</tr>
<tr>
<td>CMP Pipe Diameter - Inches</td>
<td>Base of Tie to Top of Pipe - Feet</td>
</tr>
<tr>
<td>---------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>114 to 120, incl.</td>
<td>5.5</td>
</tr>
</tbody>
</table>

7. Struts shall be placed after embankment is compacted to top of corrugated pipe but before any embankment is placed over the pipe. No equipment shall pass over the corrugated pipe until struts are in place and 3 feet of embankment is in place over the pipe.

8. Struts shall consist of 6 by 6 inches longitudinal timbers at the invert and top of corrugated pipe separated by 6 by 6 inches timber posts at 3 feet centers. Struts shall be shimmed tight using hard wood wedges nailed securely in position. Placement of struts shall be limited to the portion of corrugated pipe located within 12 feet of centerline of tracks.

9. Unless otherwise directed by the Engineer, struts shall be left in place until track laying is completed after which the struts shall be removed.

10. The furnishing and placing of field strutting material shall be considered incidental to pipe placement.

11. Reinforced Concrete Pipe.

12. Installation shall be in accordance with AREMA Manual For Railway Engineering Chapter 8, Part 10.4, Installation.

13. Gaskets out of position or loaded with dirt or other foreign material shall be removed, cleaned, and replaced before the joint is made.

3. Polyethylene and PVC Pipe:

1. Install in accordance with the manufacturer’s written recommendations and as shown in the Plans.

4. Structural Plate Pipe:

1. Structural plate pipe shall be erected at the site, in accordance with detailed plans or instructions of the Engineer.

2. Where two or more structural plate pipes are used, they shall be a minimum of 1/2 pipe diameter or one-third of pipe-arch span apart. Where practicable, in the opinion of the Engineer, a space of 10 feet may be provided between pipes to facilitate compacting fill material around the pipe with heavy equipment.
3. Structural plate pipes may be made up of corrugated plates of variable gages. The invert plate may be two gages heavier than the plates for the sides and top of the pipe section, and heavier gage plates may be used in the center sections than at the end sections of the pipe. An erection diagram will be provided and must be followed without exception.

4. Strutting of structural plate pipe, if required, shall be as shown in the Installation Procedures or Erection Diagram.

5. Structural plate pipes are to be assembled at the site with as few bolts as possible until all plates are in place. Three or four untightened bolts near the center of each plate along the longitudinal and circumferential seams are sufficient, and after several rings have been assembled the remaining bolts can be inserted, the corner bolts being the last. Bolts are to be tightened progressively from one end of the structure to the other after assembly has been completed, and shall be check-tightened in the same manner to be sure none is left loose. All bolts shall be tightened with proper tools, either hand or power wrenches, initially to a minimum of 100 ft-lbs. and a maximum of 300 ft-lbs of torque. After backfilling is complete, bolts are to be checked for tightness and re-tightened if no longer torqued within these parameters.

6. Where heavy camber is necessary, erection procedures may be modified, but only as specifically approved by the Engineer for each such case.

7. At locations where the existing structural plate pipe is to be extended with new plates, the joining end of the existing pipe shall be free of breaks, cracks or other defects. The Contractor must remove any existing damaged and beveled plates so that extension can be made using standard plates. Such removal will be considered incidental to the cost of the pipe, and no direct payment will be made therefore.

8. Identification tag, supplied by manufacturer, shall be attached near top of and inside of pipe at upstream end.

9. End plates must be removed and remaining plates and bolts inspected for reuse by the contractor prior to ordering the extension culvert material. Existing bolt holes shall be reused for the extension connection.

10. In stock and vehicular underpasses which are to receive concrete invert paving, the area to be covered by concrete shall be clean and dry. Wire mesh reinforcement may be tack welded to bolts.

D. Backfill and Embankment:
1. General:

1. When the pipe foundation line is below natural ground, compacted backfill, placed in accordance with SCRRA Standard Specification 31 20 00 shall be placed around the pipe in the area within the limits of the embankment section which was removed as channel excavation. The upper limit of this backfill shall be the top of pipe elevation or the elevation of natural ground surface as it existed before any excavation was made, whichever is lower.

2. Embankment above natural ground shall be placed in accordance with SCRRA Standard Specification 31 20 00. When the upper limit of backfill is the top of pipe elevation, three (3) feet depth of material shall be placed above the pipe without compaction. This material shall be compacted in accordance with Section 31 20 00 at the time the roadbed receives its final finish.

2. Placing and Compacting Backfill and Embankment:

1. The placing of embankment around pipes is to be started with the approval of the Engineer only after assembly and erection work has been completed in every detail. Embankment material to be placed around pipe must be approved by the Engineer in accordance with Section 31 20 00.

2. Embankment under the haunches, along each side for a minimum width equal to the pipe diameter, and over the pipe is to receive special handling both as to placing and as to compaction. Except as modified by the provisions of Section 31 20 00, embankment shall be hand tamped directly under the haunches throughout the width beyond the reach of machine compacting equipment.

3. All material, except that noted to be left non-compacted until the roadbed is completed on top of the culvert, shall be compacted to the full amount required by Section 31 20 00. Compaction methods and equipment shall be approved in advance by SCRRA.

4. If the Engineer permits the clear distance between multiple pipes, or the clear distance between pipe and cut face, to be less than 3 feet, lean concrete slurry shall be used to fill under the haunches and to a minimum depth of the spring lines of the pipe installation. The concrete slurry mix shall be approved by the Engineer. Care shall be taken to ensure that the concrete slurry does not float the pipes above their intended elevation.

5. The embankment directly above the pipe for a distance of one-third pipe diameter, but not less than 3 feet is to be placed without compaction.
6. Where the distance from subgrade to top of pipe is less than 3 feet, the excess material shall be left in place until the roadbed receives its final finish. At this time the material over the pipe to a depth of 1 foot below subgrade elevation shall be compacted to the full amount required by Section 31 20 00.

7. Care must be taken to prevent water from leaking through the fill or along the side of the pipe. When granular materials have been used for bedding or backfill, the ends of such material must be sealed against infiltration. This can be done by using impervious embankment material for 3 feet at both ends of the pipe.

E. Headwalls and Connection Structures:

1. Reinforced concrete headwalls and connection structures shall be constructed in accordance with the details indicated on the Contract Plans and the appropriate SCRRRA Engineering Standards, ES6301 through ES6310 for the type of culvert or drain pipe placed and Section 03 31 00 or Section 34 80 43.

2. Prefabricated concrete or steel headwalls shall be constructed in accordance with the details indicated on the Contract Plans and in accordance with the manufacturer’s instructions for the products called out thereon.

3. Seal all joints at headwalls and connection structures to ensure water tightness.

F. Installation Finalization:

1. The Contractor must remove all waste materials, including unacceptable excavated material, trash, and debris from the worksite and legally dispose of it off site at no additional cost to SCRRRA.

2. At the conclusion of the Work, the Contractor must thoroughly clean the entire length of all the installed, extended or modified culvert by flushing with water or other means to remove all dirt, stones, pieces of wood, or other material, which may have entered the culvert during the construction period. Debris cleaned from the lines shall be removed from the Worksite. If there are any remaining obstructions after such cleaning, such obstructions must be physically removed by the Contractor.

3. Contractor must provide Engineer 48 hours advance notice to perform final inspection and acceptance of culvert installation.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Culvert Pipe will be measured by the type and size of the pipe, and the unit or
fraction thereof furnished and installed in accordance with the Contract Documents and as measured by the Engineer. The quantities as contained on the Schedule of Quantities and Prices, or approved Schedule of Values, as applicable, as derived from the plans will be used as the basis for this measurement.

B. All material, work and services furnished for excavation and backfill, structural fill, crushed aggregate bedding material, structural concrete, Concrete for connection structures between existing and new culverts and headwalls and precast concrete will be included in this Section and are considered incidental to work under this Section and will be measured by the unit or fraction thereof furnished and completed in accordance with the Contract Documents and as measured by the Engineer.

4.02 PAYMENT

A. Culvert and drain pipe furnished and installed in accordance with the Contract Documents will be paid for at the contract unit price for each type and size of pipe, as listed on the Schedule of Quantities and Prices. This price shall be full compensation for furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals necessary for culvert and drain pipe described by the Contract Documents.

B. Full compensation for excavation and backfill, structural fill, crushed aggregate bedding material, structural concrete, Concrete for connection structures between existing and new culverts and headwalls and precast concrete shall be considered as included as listed on the Schedule of Quantities and Prices.

END OF SECTION
SECTION 33 46 00

UNDERDRAINS

PART 1 - GENERAL

1.01 SUMMARY

A. The Work in this Section consists of furnishing all labor, materials and equipment necessary and incidental to providing underdrains, and subsurface drainage Materials behind foundations, piers, retaining walls and along track bed. The Work includes connecting system to existing or new storm drains as indicated on the Contract Plans.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 - General Requirements.
3. Section 31 20 00 - Earthwork.
4. Section 31 50 00 - Excavation Support and Protection.
5. Section 34 80 23 - Subdrainage System for Railroad Bridges and Retaining Walls.
6. Section 33 42 00 - Culvert and Drainage Pipe

1.02 REFERENCES

A. American Railway Engineering and Maintenance of Way Association (AREMA) – Manual for Railway Engineering.

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

1. M294 Corrugated Polyethylene Pipe

C. ASTM International (ASTM)


F. SCRRA: Engineering Standards.

1.03 DEFINITIONS

A. The term “underdrain” pipe is in reference to any perforated plastic underdrain pipe as indicated in the Contract Plans.

B. The term “plastic” as it relates to pipe and fittings is in reverence to high-density polyethylene (HDPE).

C. The term “permeable rock” as it relates to bedding is in reference to Aggregate Base Material as indicated in the Materials section of this Specification.

D. The term “ballast” rock as it relates to bedding of underdrain pipe is in reference to bassist material as indicated in Part 2 of Section 31 11 26 of the Standard Specifications.

1.04 SYSTEM DESCRIPTION

A. Underdrain: Underdrain shall consist of furnishing and placing under-drain pipe adjacent to the tracks as detailed on the Contract Plans.

B. Permeable Backfill Material: Permeable backfill Material shall consist of furnishing and placing permeable backfill material around underdrains in accordance with details shown on the Contract Plans and this Section.

C. Trenching and Backfilling for the underdrain as shown on the Contract Plans or other Referenced Standard.

1.05 SUBMITTALS

A. Submit, under the provisions of Division 01 the following information:

1. Submit Product Data, certifications and samples for each Material used in this Section. Samples of permeable rock shall be no less than 150 lbs and shall be accompanied with Supplier’s certified test data.

PART 2 - PRODUCTS

2.01 BEDDING MATERIALS

A. Sand bedding shall conform to Caltrans Section 19-3.025B.

2.02 PERFORATED AND SOLID DRAIN PIPE

A. Plastic, corrugated, smooth interior to conform to AASHTO Designation M252 (HDPE), OR M294 (HDPE) Type S with Class1 perforations or M304 (PVC).
B. Fittings for plastic pipe shall be of the same material and from the same manufacturer as the plastic pipe.

C. Corrugated metal pipe: Polymeric Coated Corrugated Galvanized Steel Pipe conforming to AREMA Manual, Volume 1, Chapter 1, Section 4.4.2. Perforations, where indicated, shall be per Chapter 1, Section 4.3.3.2 of the AREMA manual.

2.03 OUTLETS RISERS AND CLEANOUTS

A. Outlets, risers and cleanouts shall be of the same materials as the perforated pipe and shall be supplied from the same manufacturer. Riser cover shall be as detailed on the Contract Drawing.

2.04 GEOTEXTILE

A. Geotextile shall conform to Caltrans Standard Specifications Section 88-1.03.

2.05 STRUCTURAL BACKFILL

A. Structural backfill shall be Class B.

PART 3 - EXECUTION

3.01 PREPARATION

A. Preparation of site for the installation of underdrains shall be in accordance with Part 3.01 of Section 33 42 00 of these Specifications.

3.02 HANDLING OF MATERIAL

A. Handling of underdrain materials shall be in accordance to Part 3.02 of Section 33 42 00 of these Specifications.

3.03 EXCAVATION AND EXCAVATION SUPPORT

Excavation and excavation support shall be in accordance with Section 31 50 00 and Section 31 20 00.

A. Subgrade for drainage installation shall be free of rock, rubble, debris, or stones larger than 1.5 inches. If this condition is present, excavate an additional 4 inches, and place 4 inches of sand bedding material at no additional cost to SCRRA.

3.04 UNDERDRAIN INSTALLATION

A. Place the filter fabric as indicated. Place the long axis of the fabric parallel with long axis of the pipe. Filter fabric sections shall be overlapped a minimum of 12 inches.
B. Place 6 inches of permeable rock on the filter fabric. Grade the rock to the line and grade indicated for the perforated drainpipe.

C. Install aggregate filter material above the bottom of the trench and below the pipe to the depths as indicated on the Contract Plans. The depth aggregate filter material above and around the pipe shall also be as indicated on the Contract plans.

D. Installation of ballast material as for bedding material should be per the limits as shown in the Contract Plans.

E. Place the perforated or slotted drain pipe with the perforations or slots facing down in a semi-circular seat prepared in the permeable rock. Connect sections of pipe in accordance with the manufacturer’s instructions.

F. Continue placing permeable rock in 4 inches layers under the sides and to the spring line of the pipe. Tamp material to provide thorough compaction under and on each side of the pipe. Successive layers of permeable rock may be placed in 8 inches layers and thoroughly compacted to the indicated depth shown on the Contract Plans. Exercise caution not to damage the filter fabric. Torn or punctured areas of filter fabric shall be repaired by placing a piece of fabric that is large enough to cover the damaged area plus 12 inches of overlap on all sides.

G. Complete permeable rock backfill as indicated and close the filter fabric at the top of this backfill with 12 inches lap per the detail shown on the Contract Drawing.

H. Place and compact structural backfill in accordance with Section 31 20 00. Exercise caution not to damage the filter fabric and sheet drain material.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Underdrains will be measured by the individual unit furnished and installed in accordance with the Contract Documents and as measured by the Engineer. The quantities for each item included in the Schedule of Quantities and Prices or approved Schedule of Values as derived from the Contract Plans will be used as the basis for this measurement.

B. Underdrain connections are incidental to the items listed above and will not be measured separately for payment.

4.02 PAYMENT

A. Underdrains constructed in accordance with the Contract Documents shall be paid for at the contract unit price as listed in the Schedule of Quantities and Prices. This price shall be full compensation for furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals necessary for all
underdrains described by the Contract Documents.

B. Underdrain connections are incidental to the items listed above and will be included in prices of the underdrain pipe listed above.

END OF SECTION